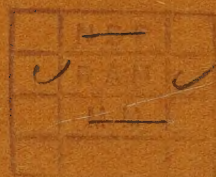




NORTHERN REGION OF NIGERIA

**Annual Report of the Department
of Agriculture of the Northern
Region of Nigeria
1955-56**

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**Annual Report of the Department of Agriculture
Northern Region of Nigeria 1955-56**

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FOREWORD

BY

THE HONOURABLE MALLAM MOHAMMED MUSTAFA, M.H.A.,
MINISTER OF AGRICULTURE, NORTHERN REGION

The shortage of staff continued to restrict the activities of the Department (as it then was) during 1955-56 as it did in previous years. However, I am glad to be able to say that subsequently the number of senior staff improved considerably. The junior staff position still remains acute, but there are signs that the public are beginning to appreciate the importance of agriculture to the economy of this Region and that young men are showing more interest in a career in this Ministry. A major recruiting effort is being planned to attract more school-leavers in December, 1958.

Nevertheless, despite the continuing staff problems, this report records heartening progress particularly in the field of research.

I would like to congratulate all officers on another year of solid achievement of fundamental value to the Region.

Kaduna,
26th April, 1958



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PART I

A REVIEW OF THE TEN-YEAR DEVELOPMENT PLAN

The year 1955-56 was the last year of the period covered by the Ten-Year Plan of development and welfare for Nigeria; special reference therefore is made in this report, to the degree of development of agriculture during that period, compared with the aims outlined in the Ten-Year development plan.

2. The plan in broad outline called for an increase in staff for field and research work to allow for an expansion of the Department's services in general, and the development of new spheres of activity in research, irrigation, the use of fertilizers, and in mechanisation. This expansion of staff was to be achieved by the recruitment of officers with (a) degree qualification but no post-graduate training, (b) diploma qualification; and an expansion of agricultural schools for training technical assistants in this country.

3. Considerable success can be recorded towards the achievement of these aims. It will be seen that the number of research officers has risen during the period from two to a team of nineteen specialist officers devoted entirely to research in agriculture for the Northern Region, and that the officers engaged in extension work have risen from twenty-six in 1946 to a total of eighty-eight. In addition, sections for the development of irrigation and agricultural mechanisation have come into being during the period.

4. Whilst the staff position has improved to a marked extent, the main increase did not take place until the last years of the Ten-Year period and the full benefit of their recruitment and work will not be seen for some time to come. Continued shortage of suitably qualified staff, (there were 112 vacancies in an establishment of 204 senior staff at 1st April, 1956,) still constitutes a limiting factor in the rate at which agricultural development can proceed.

5. The improvement in the staff position has made available officers for staffing the School of Agriculture at Samaru. This, combined with new buildings, modern lecture rooms, laboratories and student quarters, has led to an improvement, not only in the numbers of students trained but also in the standard of training given. A table showing the comparative output of trained students is given at APPENDIX I of this report.

6. During this period, five Nigerian members of the staff were promoted from the Junior to the Senior Service.

7. During the ten years, twelve Cattle Multiplication Centres have been established and stocked, stock farms established at Daudawa and Ilorin, and a selected Ndama herd of ninety-two head imported from French Territory, for breeding purposes. The success of efforts made to encourage the inclusion of cattle in arable farming are clearly shown by the comparative

figures for mixed farmers. At the beginning of 1946 there were 2,547 mixed farmers in the Northern Region and at the end of 1955, 12,954.

8. Research into the possible uses of fertilizers led to the recommendation in 1950 of the use of superphosphate, primarily on groundnuts. In the first instance this was issued free to farmers, to accustom them to its use, but gradually these free issues were reduced and the fertilizer offered for sale. This campaign has in a short period met with considerable success.

9. Preliminary investigation into possible irrigation schemes started in 1946, and in 1950 construction began on the Edozhigi pilot irrigation scheme in Niger Province. Since then a total of 9,000 acres have been brought under controlled irrigation and investigations and plans are in hand for a further 7,500 acres.

10. Seventeen Land Settlement Schemes have been brought into being in the Region. The C.D.C. Scheme at Mokwa was taken over by the Department in 1954, where the major problem of soil conservation was tackled as a first consideration. Work is now in progress to protect the farmed areas.

11. Agricultural Engineering workshops have been built at Samaru, staff assembled and trained, and a wide range of tractors and implements tested. Five experimental upland farms for tractor cultivation were opened, from which much valuable data was obtained. Mechanical cultivations on both large and small scale, have been carried out on fadama lands for rice production. In the main the mechanical cultivation of fadama lands has been very much more successful than that of upland, and in most cases the upland experimental farms failed to yield economic returns.

12. In detail, the following have been achieved:—

- (i) A great expansion of staff and laboratory facilities for research, and staff for extension and field work.
- (ii) The construction of new school buildings and the development of facilities for agricultural technical training.
- (iii) The successful encouragement of methods of farm husbandry to include cattle; and the establishment of cattle multiplication centres where suitable cattle can be bred for distribution to mixed farmers.
- (iv) The successful introduction of fertilizers to the Region's farming.
- (v) The establishment of an agricultural headquarters at Maiduguri.
- (vi) The formation of an Irrigation Division.
- (vii) The construction of agricultural engineering workshops, the assembly of a staff of Engineers, the training of technicians, and the testing of a wide range of tractors and implements.
- (viii) A poultry experimental station brought into being at Riyom in Plateau Province.
- (ix) The formation of a Federal Rice Research Station in Niger Province.

- (x) The encouragement of the use of sugar crushers.
 (xi) The establishment of fruit nurseries and vegetable gardens to encourage their cultivation as a valuable part of general efforts to improve diet.

13. There is no available data on actual output of farms, or details of internal trade in produce. However, the comparative volumes of major crops exported from the North will afford a measure of development and increased output. It will be seen that the total tonnage in 1956 has increased about half above that of 1946 and the export revenue from those crops has increased five fold in the same period.

Tons and Values exported

	1946		1950		1956	
	<i>Tons</i>	<i>Value £</i>	<i>Tons</i>	<i>Value £</i>	<i>Tons</i>	<i>Value £</i>
Benniseed ...	7,334	77,000	14,372	704,000	12,978	883,000
Cotton ...	6,612	536,000	12,623	2,975,000	33,174	9,380,000
Groundnuts ...	286,946	5,675,000	317,000	15,237,000	379,000	23,134,000
Total ...	300,892	6,288,000	343,995	18,916,000	443,152	33,397,000

THE YEAR 1955-56

14. *The Season-Weather*.—Whilst on the whole there was satisfactory rainfall, some areas experienced difficulties at planting time on account of delayed and patchy early rains. In most areas, there was an abrupt ending of the rains and quick change to “Harmattan” conditions.

15. *Food and Cash Crops: Cereals*.—Generally a good year and especially in the more northerly provinces where grain crops yielded particularly well. The early cessation of rains in some areas reduced yields but in all areas grain was in good supply and prices generally below those of the previous year.

16. *Root Crops*.—With few exceptions, cassava, yams and sweet potatoes yielded well. Increased acreages of cassava are reported from Bauchi and Bornu Provinces. Heavy rainfall in Sokoto Province reduced yields of sweet potatoes to less than normal, and there were reports of heavy yam beetle infestation in Benue Province.

17. *Sugar*.—All reports indicate incidence of Red Rot disease this year. A decline in the acreage of sugar in Katsina was attributed to difficulties experienced in previous seasons with Red Rot disease. It was reported that much of the land previously cropped with sugar is now being sown with rice. On the other hand Bauchi and Ilorin Provinces report an increased acreage of sugar cane.

Production of sugar is mainly for chewing and the production of brown sugar is only a secondary effort. The following table gives yearly totals of sugar crushers in operation, and whilst no exact figures are available, an annual output of ten tons of mollasses per mill can be reasonably expected.

<i>Year</i>	<i>No. of Sugar Mills</i>			<i>Year</i>	<i>No. of Sugar Mills</i>		
1946	172			1951	656		
1947	242			1952	662		
1948	244			1953	563		
1949	375			1954	557		
1950	665			1955	623		

18. *Tobacco*.—Particulars of cured leaf purchased by the Nigerian Tobacco Company are as follows:—

<i>Year</i>	<i>Lbs</i>			<i>Year</i>	<i>Lbs</i>		
1946	171,040			1952	2,211,444		
1947	82,272			1953	1,610,778		
1948	217,120			1954	1,588,148		
1949	300,715			1955	1,811,642		
1950	735,865						
1951	1,315,316						

Apart from the production of tobacco of Virginia Varieties for sale to the Nigerian Tobacco Company, there is a considerable amount of tobacco grown for local trade or home use in several provinces, notably Plateau.

EXPORT CROPS

19. *Groundnuts*.—This was a particularly favourable season in nearly all areas, and total purchases of 530,215 tons for export, was a record.

A campaign was initiated to improve quality by an improvement in standards and methods of decortication. The Marketing Board introduced a new "Special Grade" for which a premium price was offered, and hand decorticating machines were offered for sale in the main producing areas. Publicity was given to this, and of the final total tonnage purchased, about 5 per cent were "Special Grade".

Total export purchases recorded for the years 1946-47 to 1955-56 were as follows:—

<i>Tons Purchased for Export</i>							
<i>Year</i>		<i>Tons</i>		<i>Year</i>		<i>Tons</i>	
1946-47	...	...	322,699	1951-52	...	...	418,255
1947-48	...	...	329,581	1952-53	...	...	430,926
1948-49	...	...	328,072	1953-54	...	...	424,616
1949-50	...	...	188,118	1954-55	...	...	372,776
1950-51	...	...	142,526	1955-56	...	...	530,215

20. *Cotton*.—Whilst this year's total purchase of export seed cotton showed a reduction on that of last year, it should be noted that the purchases in 1954-55 were a record, and that this year still follows the general trend of a steady increase in exports.

Yields could be considerably increased if farmers followed more closely the advice given them to plant early. In years of normal rainfall there should be no difficulty in arranging the planting programme so that cotton is sown in the early part of July. However many farmers continue to plant as late

as August or even September which, by reason of shortening the growing period, reduces the potential yield.

The general observance of the "close" season for cotton still leaves much to be desired, in spite of all the publicity given to this most important aspect of cotton husbandry.

Total purchases of export seed cotton for the years 1946-47 to 1955-56 were as follows:—

<i>Year</i>	<i>Tons</i>	<i>Year</i>	<i>Tons</i>
1946-47	18,300	1951-52	60,748
1947-48	9,862	1952-53	47,041
1948-49	25,316	1953-54	73,191
1949-50	31,417	1954-55	97,663
1950-51	40,862	1955-56	80,122

21. *Benniseed*.—It was a very good season for this crop and there was a record purchase for export of 18,376 tons of which 17,346 tons came from the Region's main producing area: Tiv Division of Benue Province.

Total Purchase for Export 1946 to 1955

<i>Year</i>	<i>Tons</i>	<i>Year</i>	<i>Tons</i>
1946-47	4,085	1951-52	10,387
1947-48	8,605	1952-53	13,775
1948-49	15,642	1953-54	13,447
1949-50	13,385	1954-55	15,809
1950-51	9,188	1955-56	18,376

22. *Soya Beans*.—Yields were about average but increased acreages of soya beans were reported from Benue and Niger Provinces and total purchases for export showed an increase this year.

Purchases for Export 1946-47—1955-56

<i>Year</i>	<i>Tons</i>	<i>Year</i>	<i>Tons</i>
1946-47	Nil	1951-52	8,038
1947-48	10	1952-53	3,884
1948-49	738	1953-54	8,731
1949-50	956	1954-55	9,109
1950-51	3,520	1955-56	9,596

23. *Livestock*.—Most provinces reported a good and healthy year for all classes of livestock, but in Kano there was a major and widespread outbreak of Foot and Mouth disease in trade cattle, which spread to a large commercial piggery, where 12,000 of a total of 16,000 pigs succumbed to the disease.

24. *Staff of the Department*.—The Senior Service staff situation has improved since last year, but the further losses of Junior Staff constitutes a grave problem. A successful extension service depends largely on the ability of that service to deal with farmers at the farm level. Well trained, enthusiastic assistant officers in adequate numbers are essential to the development of agriculture in this country. In spite of the improved training facilities, the improved condition of service, and the very real chances of promotion

in the Department, agriculture as a career still fails to attract sufficient numbers of the right type.

The following summary includes all but administrative and clerical staff:—

<i>Rank</i>	<i>Establishment</i>	<i>No. at 1-10-55</i>	<i>Vacancies</i>
Director of Agriculture	1	1	—
Deputy Director of Agriculture	1	1	—
Assistant Director of Agriculture	1	—	1
Assistant Director of Agriculture (Irrigation)	1	—	1
Assistant Director of Agriculture (Research)	1	1	—
Principal Agricultural Officer	13	1	12
Principal Research Officer	1	1	—
Principal Agricultural Engineer	1	1	—
Principal Irrigation Engineer	1	1	—
Soil Conservation Specialist	1	—	1
Principal School of Agriculture	1	—	1
Senior Agricultural Officers	10	6	4
Agricultural Officers	33	24	9
Agricultural Superintendents	22	15	7
Apiculturist	1	1	—
Economist	1	1	—
Specialists	34	10	—
Specialist Assistants	8	2	6
Irrigation Engineers	11	10	1
Agricultural Engineers	3	3	—
Accountant	1	1	—
Mechanic Demonstrators	10	9	1
Administrative Assistant, Grade I	2	1	1
Administrative Assistant, Grade II	3	2	1
Personal Assistant	1	—	1
Assistant Agricultural Officer, Grade I	14	8	6

25. *Staff Training: School of Agriculture. Samaru.*—On 1st April, 1955 there were 101 students in the school already engaged in the various courses and forty-eight more entered for the 1956 courses (Agricultural Assistants and Native Administration).

During the year thirty-two were posted for duty on completing their A.A. course; thirty returned to the N.A. having also completed their course; one obtained a scholarship; and ten left for various reasons. At the end of the year there were seventy-six students still in the school.

The present courses available are as follows:—

(i) *Assistant Agricultural Officers.*—A 2-year course for selected students who have already done one year of the Agricultural Assistants course.

(ii) *Agricultural Assistants.*—A 2-year course.

(iii) *Junior Native Authority.*—An 11-month course for N.A. Agricultural Assistants.

Staff.—There were unavoidable changes in staff during the year, due to leave and transfers; but except for a short period, the senior teaching staff was up to full establishment. The only senior post which remained vacant was that of Administrative Assistant.

It was not possible to achieve the aim of having suitable senior staff doing all the teaching; so the policy of specialisation among the junior teaching staff was continued.

The Nigerian College of Arts, Science and Technology provided lectures in chemistry, botany and zoology, for the Assistant Agricultural Officers course, which started in January 1955 and finished in March, 1956.

Buildings.—At the Main Farm an isolation pen costing £150 and a store costing £500 were completed during the year.

At Training Farm No. 1, necessary repairs were made to the cattle pens and milking shed, and the silage pit was lined with laterite and concrete.

At Training Farm No. 3, extension, repairs and general reconstruction of the farm buildings were carried out. A sports pavilion was made by converting a store. The School hostel was improved by reconstructing the old kitchen and building a new fireplace.

26. *Departmental Farms and Centres.*—Full details of experiments and trials carried out on Departmental farms are reported in the research sections of this report with brief details and experiments on various aspects of local crops under local conditions. The experiments are designed, recorded and statistically analysed under the direction of the Regional Research Station, Samaru.

27. *Mokwa Agricultural Project: Weather and General.*—The first rain was on 19th April with intermittent showers until May. Rainfall in June was heavy, causing a good deal of erosion in some areas planned for guineacorn and cotton. Rainfall for the remainder of the year was adequate.

Some damage from animals and vermin to newly planted seed was noted around the outer perimeter of fields, which necessitated replanting. Although precautions were taken against bushfires a certain amount of damage occurred, affecting some 38 acres of guineacorn.

MAIN FARM

Guineacorn (Farafara).—Planting commenced immediately after the first rains. Most farmers had completed planting by the end of May. All fields were inter-row cultivated and latter re-ridged. Before harvesting, grass along the roads was burnt to make fire traces. It was intended that threshing should be done by a machine, but owing to its unsatisfactory performance most of the threshing was done by hand. A small area was affected by “Striga”, but the general result was satisfactory.

Groundnuts.—Early planted seed developed well, but the later planted areas suffered severely from “rosette”. Some farmers did well, but for the majority it was an unprofitable crop.

Guineacorn (Kaura)—Planting took place between 7th and 20th July and the crop developed well, the short straw proving easier to handle than that of farafara.

Cotton.—Planting took place in mid-July and germination was generally good, except in some instances, where wide spacing and a low seed rate gave poor results.

Later development was disappointing, with a small number of bolls set, and a high incidence of pest damage. Yields were low and did not give a return to cover the cultivation charges. In view of this the cultivation charges were reduced by half.

Nurseries.—The following were planted from nurseries during the year:—

Sweet Orange	...	...	...	...	38
Tangerine	...	...	...	...	30
Cashew	...	...	...	...	125

In addition some 200 mango seedlings were available for budding.

Grain Storage.—Storage of the guineacorn crop in sacks at the main station was done, with little appreciable loss over the year; and practically the whole of the crop was sold before the end of March.

Livestock.—The two Ndama bulls kept on the Settlement area continued to thrive.

28. *Settlements.*—In the village of Ndayako where two thirds of the settlers live, there was a tendency for whole families to move in, thus establishing a true communal life on which the success of the scheme depends. The Native Administration grant of £3 for a completed new house was taken up by several settlers and has given impetus to this.

In Pamnini there still remained the problem of settler's wives choosing to remain in their home villages for at least part of the year, with attendant domestic difficulties and upheavals.

Until this year, share cropping was practised, and many of the farmers had difficulty in understanding the new system of charging cultivation costs to their personal accounts, which were credited with the full value of their crops.

Cotton and groundnuts were bought at the gazetted price, and stored in sacks at the main station. This again proved most successful as the price paid to the farmers at harvest was above current market price, and given good storage conditions the corn can be kept until market prices are favourable.

Survey of Operations.—There were eighty-six settlers averaging 20½ acres each.

Planted				Crop	Acreage	Yield	Yield per acre
19th April to 2nd June	...	...	...	Farafara	696	318 tons	1,023 lbs
7th to 20th July	...	...	...	Kaura	554	246 tons	985 lbs
Late May to 2nd June	...	...	...	Groundnuts	252	39 tons	346.6 lbs
Mid July	...	...	...	Cotton	252	25,000 lbs	1,000 lbs

Cultivation charges:

Guineacorn	...	...	...	...	7	} per acre
Groundnuts	...	...	...	...	6	
Cotton	...	...	...	...	5	

Superphosphate was applied at the rate of $\frac{1}{2}$ cwt per acre to farafara cotton and groundnuts. Superphosphate and sulphate of ammonia were applied at the rate of $\frac{1}{2}$ cwt per acre to kaura.

Settlers' incomes varied considerably, one man making a net profit of £231—while the maximum debt outstanding was one of £69. Altogether twenty-eight of the eighty-six settlers finished the season with a debit balance, the total outstanding debts being £718-14s-3d.

At the end of the year twenty-two settlers left.

29. *Cattle Multiplication Centres.*—By the end of the year there were twelve Cattle Multiplication Centres in the Region:—

Province								C.M.C
Bauchi	...	...	...	...	...	...	...	Darazo
Bauchi	...	...	...	...	...	...	...	Tumu
Benue	...	...	...	...	...	...	...	Raav
Bornu	...	...	...	...	...	...	...	Marguba
Katsina	...	...	...	...	...	...	...	Kabomo
Katsina	...	...	...	...	...	...	...	Kukar Aljanno
Kano	...	...	...	...	...	...	...	Birnin Kudu
Kano	...	...	...	...	...	...	...	Gumel
Sokoto	...	...	...	...	...	...	...	Kotorkoshi
Sokoto	...	...	...	...	...	...	...	Talata Mafara
Sokoto	...	...	...	...	...	...	...	Dogon Daji

These centres were still in the process of establishment of buildings and herds.

30. *Mixed Farming.*—The adoption of the system of mixed farming continued to expand but in some areas lack of suitably trained extension staff was one of the major obstacles to more rapid development. The totals of operating mixed farmers given, are of those farmers assisted in varying degrees with finance in setting up their farms; there are considerable numbers of farmers who incorporate livestock in their farming system who are not included in these totals.

Total numbers of operating mixed farmers for the year ending 1946-47 to 1955-56 were as follows:—

Year				Year			
1946-47	...	...	3,327	1951-52	...	...	8,841
1947-48	...	...	4,068	1952-53	...	...	10,943
1948-49	...	...	4,720	1953-54	...	...	11,625
1949-50	...	...	5,763	1954-55	...	...	12,761
1950-51	...	...	7,052	1955-56	...	...	12,954

31. *Fertilizer Campaign*.—Sales of superphosphate increased by 3,717 ($\frac{1}{2}$ cwt.) bags compared with last year. In some provinces, e.g., Katsina, the use of fertilizer is becoming more and more a standard practice, whilst in others the campaign to encourage its use is still in its infancy. The following table lists sales and free issues since the first year of the introduction of fertilizers.

<i>Superphosphate</i>							<i>Free Issue</i>	<i>Sales</i>
<i>Year</i>							($\frac{1}{2}$ cwt bags)	($\frac{1}{2}$ cwt bags)
1950	...	...	...	...	...	...	30,000	Nil
1951	...	...	...	...	...	...	67,000	25,000
1952	...	...	...	...	...	...	32,000	22,000
1953	...	...	...	...	...	...	135	27,806
1954	...	...	...	...	...	...	64	24,472
1955	...	...	...	...	...	...	113	28,189

Mixed superphosphate and sulphate of ammonia and straight sulphate of ammonia has been recommended in Ilorin, Niger and Kabba Provinces. Demonstration plots were laid down, trials held on farmer's fields and some small quantities sold.

32. *Nurseries*.—The effort of the past few years to increase the amount of fruit grown for household consumption began to meet with success. Nurseries reached a stage where considerable supplies of seedlings were available for distribution. There was particular success this year in Bornu Province where from eleven nurseries (eight of which have been started since 1946,) 300,000 guava, citrus, lime and pawpaw seedlings, and 7,000 budded mangoes, were raised for distribution in the rainy season of 1956. In addition, these nurseries sold 68,967 lbs. of fruit.

In addition to the 307,000, citrus, guava, pawpaw, and mango raised in Bornu, 3,260 kola, 16,869 oil palm and 8,996 coffee seedlings were distributed. A further total of 354,700 citrus, guava, pawpaw and mango, 500 oil palm and 788 cocoa seedlings were raised and ready for distribution by the end of the year.

33. *Irrigation*.—The development of irrigation in the Region still suffered from lack of qualified engineers which in its turn made it impossible to train assistants and so build up a balanced staff. For this reason, work during the year was confined to Niger, Ilorin, Bornu, Kano and Sokoto Provinces. The following schemes in Niger Province are given in detail since they represent the major pilot schemes of the Region. All these were financed from Colonial Development and Welfare funds.

(i) *Wuya Edozhigi Scheme*.—Situated on the left bank of the Kaduna river south of Wuya Ferry and west of Edozhigi village. Its objects are to build a flood bank about 5 miles long, to divert the flood waters of the Kaduna river and to form an area of about 2,800 acres which can be irrigated from the Edjiko and Kupanko perennial streams, by the construction of diversion weirs, main channels, and distributaries.

Steady progress was made this season on the construction of the flood bank, using a new D4 tractor. Work had to stop in mid July due to heavy rains; and was resumed in late December.

Outturn was at the rate of 15,000 cubic yards per month, and the construction neared completion. It was hoped that the flood bank would be completed in June, 1956. Other work included the construction of an outlet through the southern end of the embankment; the extension of canal K2 for irrigation of the lower part of the Wuya Fadama; the construction of a syphon across canal K3 for disposal of flood water; the extension of canal E2 to irrigate the lower portion of the Edozhigi Fadama; and the construction of drainage culverts under K2. Some of this work was completed during the year and it was hoped that the rest would be complete by July, 1956.

During the year the irrigation system was maintained by this Department, and a supply of water given to irrigated areas. About 1,200 acres were cultivated and the rice crop was generally good.

It is proposed to bring this scheme under N.A. management during the coming season and levy water rates at 20s per acre to cover maintenance costs.

On the northern side of the area, a channel about $1\frac{1}{2}$ miles long was constructed for the irrigation of some 200 acres of flood free fadama outside the area. About 60 acres were cultivated last season with satisfactory results.

(ii) *Badeggi Scheme*.—A rice area on the right bank of the Gboko river in the village areas of Tsantsaga, Magingeri, Badeggi and Masaga. The scheme has as its object the irrigation of about 2,500 acres of rice land, by the construction of a diversion weir, a contour channel 6 miles long, and a series of distributaries and field channels.

The excavation of the main contour channel was completed at the end of 1954/55, and ancillary works such as cross drains and distributaries were continued, but due to early floods work had to be stopped early in June. The canals opened for irrigation, worked satisfactorily, and good results were obtained.

Due to water supply being continued until the end of February for experiments at the Rice Research Station and agricultural experiment areas, and the heavy saturation of the ground, the access road could not be opened till March, 1956 when work was resumed on the construction of cross drainage works.

The floods in July and August 1955, caused minor damage to the main channel and revealed the necessity for more flood disposal works.

(iii) *Loguma Scheme: Location*.—Loguma village on the Katcha road about 3 miles from Katcha.

Object—To irrigate about 350 acres of Niger Fadama south of the Minna-Baro Railway line in Loguma village, by constructing a diversion weir across the Emi stream which is perennial: by constructing a leading channel about $\frac{3}{4}$ mile long and taking it in a culvert through the Railway embankment; and by the construction of field channels through the fadama.

This work was sanctioned in the year 1954/55 and negotiations with the Railway Authorities were entered into for the construction of a culvert through their embankment. Due to excellent co-operation an agreement was reached whereby the Railway Department did the work, this Department paying the cost.

The original plans for the headworks had to be revised on account of lack of suitable local materials, and it was decided to alter the design of the headworks from masonry and revetments to reinforced concrete. Detailed plans were prepared in the wet season and work started in January, 1956.

The leading channel, now about 90 per cent complete, involved the excavation by hand of about 10,000 cubic yards of earth.

The Railway Engineer completed the culvert through the Railway embankment and only some protection works remained to be done.

At the headwork, considerable difficulty was met due to very wet foundations and extremely poor subsoil. The progress on the headworks was therefore less than expected, but the foundation work has now been completed and work on the superstructure is in progress.

During the year preliminary investigation was undertaken of two more areas in the Province, totalling approximately 6,500 acres.

(iv) In Ilorin Province further detailed investigations were continued on the Pategi Scheme. Gauge readings on the Niger Fadama were regularly recorded and stream flows gauged. Sufficient information was compiled to estimate the approximate flow of the streams and the maximum floods that might be met with. The irrigation Engineer in charge of this scheme was established at Pategi.

(v) In Bornu Province construction started on the pilot scheme at Wulgo, Lake Chad, and investigations initiated at Lake Alau. Construction was started on two cattle dams in Kano Province, and a programme of investigation started for village irrigation schemes in Sokoto Province.

34. *Agricultural Engineering*.—During the year new equipment was received and the following equipment was tested:—

- Brenant Indicator
- Servis Recorder
- Crichton, Thresher
- Lucas Magneto
- Tower Disc Ridger
- Brush Cutter
- International B.T.D. 6
- Hydraulic Light Davis plough
- Steel wheels—Ferguson Tractor.

Final tests were carried out on the following groundnut decorticating machines:—

- French Somat
- South African "National Pump" machine

India "Kirloskar" (large)

American "Turner"

India "Kirloskar" (small)

English Richmond and Chandler.

Mechanical Cultivations.—Ploughing trials were carried out during the dry season, on rice land in Sokoto Province. The equipment used was—

Caterpillar D4 with light Davis Plough	} 5 furrows
Caterpillar D7 with heavy Davis Plough	
Fordson County with light Davis Plough	
Fordson County with Dragoon Plough	
Caterpillar D4 with Dragoon Plough	}

Ploughing was also done in Bauchi and Zaria Provinces.

35. *Soil Conservation.*—The responsibility for proper soil conservation and drainage lay-outs was delegated to the Engineering Branch. Lack of suitably trained staff remained a problem.

At Samaru previous work had been done in the construction of water-holding type terraces. It was found that this layout led to serious water logging, and a system of graded terraces to discharge surplus water was designed and the work started; the necessity of training staff made progress slow.

36. *Research.*—The detailed report of the work of the research sections which is published as Part II of the present Report, records the very much improved Senior Staff position. The Botany section has been strengthened by three botanists and two pathologists (one of the latter being a seconded officer of the Empire Cotton Growing Corporation), the Chemistry section by a biochemist, and the Grassland section by a plant breeder. The scope of the work has been further extended by the posting to Samaru of an entomologist, and (for two limited projects) an ecologist by the Federal Department of Agricultural Research. It has also been possible to strengthen the Agronomy and Grassland sections by the posting, with some prospect of continuity, of three agricultural officers from the Provincial list. Library development has become possible through the appointment of a librarian/publications officer.

New building has unfortunately not kept pace with the arrival of new staff, and the housing situation had become desperate by the end of the year. A long delayed contract for Senior and Junior Service quarters and the completion of a Catering Rest House at Samaru was finally signed in March, and the first of these quarters should be ready to ease the pressure which would have been caused by the return of officers from leave. Office and laboratory accommodation is now becoming increasingly difficult. with little prospect of much improvement for the next year or two.

In contrast with the Senior Staff position, the Junior staff position has continued to deteriorate. Figures at the beginning and end of the year were:—

Assistant Agricultural Officers:	3—2
Senior Agricultural Assistants and Agricultural Assistants: ...	31—27
Field Overseers	21—27
Clerical Staff	12—10

Lossess, in staff of southern origin continue, while the supply of northern staff is not yet sufficient to make good the loss, far less to provide the extra junior staff required for the efficient working of the growing senior staff. There seems little likelihood of an improvement in this trend for a year or two yet.

Agronomy.—The results of over 200 experiments conducted during the year were analysed by the Agronomy Section. Agronomic trials covered a wide range of subjects, including planting date studies on groundnuts in the Riverain area, (where early planting is at present a main factor in controlling rosette disease), striga studies, and investigations of times of application of fertilisers to guineacorn and millet.

Seed dressing studies were largely inconclusive this year except at Sokoto, where much enhanced germination and increases of around 300 lbs. grain per acre were obtained from dressed millet seed, compared with undressed seed.

A series of groundnut seed deterioration trials concluded at Daura has finally confirmed that seed of variety Samaru 38 bred at Samaru loses germinating power in store under these more northerly conditions after being once grown, as compared with seed of the local variety. This factor will have to be given special attention in further breeding work for the northern areas.

The completion of the second cropping cycle of the tests of the effect of monoculture at Samaru and Bida has confirmed the results from the first cycle, losses due to monoculture (lbs per acre) as compared with rotation, being as follows:

Guineacorn at Samaru	257	177
Guineacorn at Bida	309	314
Groundnuts at Samaru	318	246
Cassava at Bida	961	934

The effect of monoculture of cotton at Samaru and groundnuts at Bida has been insignificant in these two trials.

Botany and Plant Breeding.—Introductions from many parts of the world have again been made, and breeding and selection work has proceeded in cotton, groundnuts, benniseed, guineacorn, millet and maize. Variety trials have been carried out on a wide range of crops, including all the main food and cash crops of the Region.

Derivatives from cotton selection 26C/479 have now entered the Cotton Seed Multiplication Scheme under the name Samaru 26J. Through the success of an attempt at rapidly building up stocks of this new strain, sufficient seed has been obtained to issue to the whole of Stage D (3,000 acres) in the 1956-57 season. 26J should thus cover the whole main cotton growing area of the Region by the 1959-60 season. New cotton selections continue to show promise of even further advances in yield potential, and it is clear that the possibilities of reselection within 26C have not yet been exhausted.

Entomology.—The posting of a Federal entomologist to the Region made it possible to start systematic work on two main pest problems on cereal crops: the cereal stem borers and the sorghum midge. Considerable progress has been made in the preliminary studies.

Work on pests of cotton continued and extended previous lines and investigation, with particular emphasis on the biological aspects. Spraying trials have produced considerable increases in yield in Riverain area conditions at Kontagora for the second year in succession, but only under good cultural conditions. At Samaru, estimated loss of crop from pests and diseases was 43 per cent in the 1955-56 season.

Pathology.—Diseases receiving main attention during the year were rosette of groundnuts, bacterial blight of cotton, the cereal head smuts, and red-rot of sugar cane, and also the condition (or complex of conditions) known as "blind nuts" in groundnut.

Of 23 varieties of sugar cane tested, the four most resistant to Red-rot were POJ2725 and CO453, 281 and 413. These varieties are now being multiplied as rapidly as possible for yield and resistance testing under field conditions.

Grassland and Animal Breeding.—Transfer of the grassland work to Shika was virtually completed, but office and housing space is short until some building can be done, and the electricity supply is not yet installed.

With the partial completion of some preliminary experiments, the major problems are becoming apparent: among these are the low protein and phosphorus levels in the majority of fodder crops, and the associated problem of low soil fertility particularly in terms of nitrogen. The problem of providing feeding during the latter months of the dry season, to which conservation of hay and silage does not provide the complete answer, received special attention.

A trial of methods of management and improvement of bush grazing gave interesting preliminary indications, and on this trial cattle were successfully maintained without housing for the whole year.

Methods of controlling scrub regrowth received particular attention.

Chemistry and Soils.—Fertiliser requirements for the principal food and cash crops of the Region, were again the main objects of the investigations carried out by the Chemistry section during the period. As in previous years, trials were conducted on Government Experimental Farms wherever

possible and on farmers' own farms in areas not catered for by Agricultural Stations. Responses to fertiliser applications were generally of a high order varying from increases of 161 per cent due to dressings of superphosphate on Soya Beans in Niger Province, to 50 per cent increases on guineacorn in Plateau Province, due to applications of mixtures of sulphate of ammonia and superphosphate. The most economic results were obtained on Yams at 1cwt. per acre dressing of sulphate of ammonia producing increases of approximately 4,000 lbs. of yams per acre in Benue Province, 2,000 in Kabba Province and 2,500 in Ilorin Province. Despite the high percentage increases due to fertiliser applications on the various crops the cash profits particularly in the case of grain crops are in general disappointing due mainly to the high transport costs of the fertilisers.

A large number of samples were analysed in the laboratory for the various sections of the Station, including over 250 grass samples for the Grassland Section and over 200 soil samples for the newly formed Soil Survey unit.

The formation of this unit took place during the second half of the year and since its conception has been mainly concerned with small scale surveys of special projects, such as experimental farm sites. Two larger scale reconnaissance surveys were in progress in Zaria and Kano Provinces, the latter including detailed surveys of Kano, Dambarta and Badume experimental farms, in an attempt to correlate the infertile *Guiera* invaded soils occurring within the province. A reconnaissance survey of 100 square miles in the area of Hadejia was completed and good correlation was found to exist between vegetation and soil associations. The soils include deep wind blown sands developed from series of parallel fossildunes, associated with calcareous soils of the old flood plains. Newer flood plain soils comprised mainly of alluvial silts and clays also occur, and are considered the most suitable for possible rice cultivation within the area surveyed.

Ecological surveys carried out by a Federal Officer in Shendam, Bida and Hadejia, gave good general correlation between soil types and vegetation and the use of ecological survey side by side with soil survey showed promise of greatly speeding up the progress of the soil survey.

Owing to the very recent arrival of the biochemist, little has yet been done in this direction, but a start has been made on digestibility studies in co-operation with the Grassland section.

APPENDIX I
TRAINING COURSES ENROLMENT 1932—1956

Year Beginning 1st April		1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	Total
Number of Students Recruited each year	(i) A. A. O. Course	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
	(ii) A. A. Course	3	5	—	6	—	8	4	11	7	11	17	12	15	13	20	13	31	26	30	54	29	27	58	22	18	442
	(iii) N. A. Course	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29	23	29	28	25	30	30	194
	(iv) Total	3	5	—	6	—	8	4	11	7	11	17	12	15	13	20	13	31	26	59	77	58	55	83	64	48	648
Total Students in training at beginning of academic year	(i) A. A. O. Course	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10
	(ii) A. A. Course	3	8	5	6	6	8	12	15	18	18	28	25	33	31	40	41	38	56	64	97	97	92	83	61	41	—
	(iii) N. A. Course	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29	23	29	28	21	30	30	—
	(iv) Total	3	8	5	6	6	8	12	15	18	18	28	25	33	31	40	41	38	56	93	120	126	120	104	103	81	—
Number Successfully completed Course	(i) A. A. O. Course	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7
	(ii) A. A. Course	—	3	5	—	6	—	6	4	10	7	7	—	7	3	6	7	13	10	15	15	17	52	13	32	16	254
	(iii) N. A. Course	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	20	15	21	20	21	30	28	155
	(iv) Total	—	3	5	—	6	—	6	4	10	7	7	—	7	3	6	7	13	10	35	30	38	72	34	62	51	416

PART II.—RESEARCH AND SPECIALIST SERVICES

I.—GENERAL INTRODUCTION

By J. H. Gisborne

During the year under review, the title of the research headquarters has been changed from Northern Research Station to Regional Research Station. The reason for this is that, with regionalisation, the old title had become misleading: within Nigeria as a whole, Samaru could well be described as "Northern", but within the Region it is no more than slightly north of "Central".

The Senior Staff position has again improved considerably, new arrivals including: in the Botany Section, three Botanist/Plant Breeders and two Pathologists (one of the latter being a seconded officer of the Empire Cotton Growing Corporation); in the Chemistry Section, a Biochemist; and in the Grassland section, a Botanist/Plant Breeder. The position of the Agronomy and Grassland sections has also been strengthened by the posting to them, with a good prospect of continuity, of three Agricultural Officers from the Provincial List. Library development has been possible as the result of the appointment of a Librarian/Publications Officer.

The progress of essential work was also greatly assisted by the posting of two officers of the Federal Department, an Entomologist working full time on Sorghum Midge and the Cereal Stem Borers and Survey Ecologist posted to the Region for two limited projects in co-operation with the Regional Soil Survey.

New building has unfortunately not kept pace with staff increases, and the housing situation had become desperate by the end of the year. A long-delayed contract was finally placed in March, 1956, but the housing situation will remain very difficult until early 1957. Office and laboratory accommodation now present an increasingly difficult problem, which has been aggravated by similar building delays at the Nigerian College, which has, as a result, been unable yet to release accommodation loaned to it in 1953.

In contrast with Senior staff, the Junior staff position has continued to deteriorate. The following figures show the numbers of established Junior staff in various grades at the beginning of the last 3 Financial Years:

	at	1-4-54	1-4-55	1-4-56
Assistant Agricultural Officers		7	3	2
Senior Agricultural Assistants				
and Agricultural Assistants ...		36	31	27
Field Overseers		25	21	27
Clerical Staff		14	12	10
		—	—	—
TOTAL		82	67	66
		==	==	==

Losses of staff of Southern origin continue, while the supply of Northern staff is not yet adequate to make good the loss, far less to provide the extra

Junior staff necessary to obtain the maximum output from the growing Senior staff. There seems little likelihood of much improvement for the next year or two, and it will probably be necessary to make some contribution to the deficit in trained technical staff by expanding more rapidly than was intended the cadre of Field Overseers, who are relatively easy to recruit and who receive on-the-job training.

VISITORS

Samaru was honoured by a visit from the Premier on 31st May, 1955, and a general inspection of laboratory work took place. The Premier was accompanied by the Honourable Peter Achimugu, Minister of Natural Resources who also paid a further visit in March, 1956. The Honourable Alhaji Ali Turakin Zaria, Minister for Trade and Industry visited Samaru on 28th April, 1955.

Apart from members of the Department, the following in chronological order were among the other visitors to the station during the year:

Mr L. Leyland Cole, Shell Petroleum Company, Limited, London

Mr E. R. Williams, American Consul, Lagos

Mr J. Riley, W.A.S.P.R.U., Ibadan

Mr J. K. N. Wilde, Assistant Director of Laboratory Services, Vom

Mr E. W. Ellison, Permanent Secretary to the Ministry of Communications and Aviation, Lagos

Mr W. A. Cromwell, American Vice Consul, Lagos

Mr M. Counsell, Resident, Zaria

Mr R. C. Marc, Director of Public Works, Kaduna

Mr I. Small, Director of West African Building Research Institute, Accra

Mr N. C. A. Levy, Chairman of the Northern Region Marketing Board

M. J. Amdadiou i/c Agricultural Research Station, Tarma, Maradi

M. Pierre Gillien, I.R.H.O., Dakar

Mr D. Winders, British American Tobacco Company, London

Mr J. H. Belsham, Nigerian Tobacco Company, Lagos

Mr N. Wright

Mr I. E. Darter

Mr C. M. Carr

Mr G. Murray

} Plant Protection Limited

Mr T. C. Faulkner, Nigerian Produce Marketing Company, London

Mr J. R. Chanter, Forest Botanist, Ibadan

Mr L. T. Stevenson, Ministry of Natural Resources, Kaduna

Mr R. R. Panje, Coimbatore, India

Mr E. D. Reynolds, British Cotton Growers Association, Manchester

Mr D. W. Hall, Colonial Liaison Officer, Pest Infestation Laboratory, Slough

Dr W. F. Jepson, Imperial College Field Station, Sunninghill, Berks

Mr J. C. Duerden, W. African Stored Products Research Unit, Kano

M. J. de Carbon-Ferriere, Paris
Dr K. Ebes, University College, Ibadan
Mr H. Rhodes, M.P.
Mr R. Foot, M.P.
Mr J. Arbuthnot, M.P.
Mr J. H. Robertson, Colonial Office

METEOROLOGICAL DATA

The main meteorological data recorded at Samaru are presented in Appendix I. For the second successive year, rainfall during the peak months was well in excess of the average, but in the present case March and May were considerably drier than usual. The total of 52.97 inches for the year was the third highest ever recorded, while 1954's 58.34 inches was the highest.

SCOPE OF THE REPORT

The present report covers investigational work of the specialist sections whose headquarters are at Samaru and Shika and the trials for which they are responsible at provincial stations and on farmers' fields throughout the region. The latitudes of the provincial stations and their rainfalls and the vegetation zones in which they lie, are given in Appendix II.

The Agronomy Section: carried out numerous trials on seed dressing, planting dates and spacings for various crops, the control of Striga in Guinea-corn, fertility, fallow and rotation, cultivation methods and weed control. This section takes entire responsibility for statistical analysis of experiments from all the Sections, and in this connection it dealt with the log-books of over 200 separate trials.

The Botany Section: continued breeding and selection work in Guinea-corn, groundnuts, millet, maize and benniseed, while introductions and variety trials were carried out with soya beans, sunflower, sugar cane, tobacco, sunflower, rice, cassava, cowpeas, sweet potatoes, yams, indigenous and exotic vegetables and fruit trees. Pathological work was mainly concerned with rosette of groundnuts, the head and grain smuts of guineacorn, bacterial blight of cotton and red rot of sugar cane.

The Cotton Breeding Section: continued its programme of reselection within the Samaru 26C strain of American Allen Cotton, while the *Cotton Entomology Section* continued its studies of the bionomics of the main cotton pests and field tests of control by insecticides.

The Chemistry Section: was once more mainly concerned with widespread fertiliser trials on the main crops of the Region, and it was possible shortly before the end of the period under review to initiate a separate *Soil Survey Section*.

While the *Grassland Section* was still generally limited by the need to multiply up seed to quantities large enough for field scale trials, quite considerable progress was made with the seed available.

The *Animal Geneticist* continued his studies of available records of the few herds of cattle and goats for which these are available.

Throughout the experimental reports, significant differences are indicated by:

*** Significant at P equals 0.001

** Significant at P equals 0.01

** Significant at P equals 0.05

N.S. Not Significant.

N.A. Data not statistically analysed.

Local names of crops are used, and the botanical names of these crops are listed in Appendix III.

II.—AGRONOMY SECTION

By K. A. Watson

A.—GENERAL

CROPS

The season was rather late getting under way compared to 1954, the first planting rains not falling till 28th and 29th April, when millet was planted at Samaru. This enabled hand cleaning of *Cynodon dactylon* to be carried out with rather better results than usual and crops got off to a good start. There was some waterlogging in July, August and September. The rains ended rather abruptly in October, the last appreciable fall being on 9th October, and there was an early onset of the harmattan which probably had a depressing effect on cotton yields. Otherwise the season can be regarded as good. Table 1 shows the average yields of the main crops at Samaru for the past four years.

TABLE 1.—AVERAGE YIELD IN LB PER ACRE OF MAIN CROP 1952-55

Season	<i>Seed Cotton Samaru 26C</i>	<i>Guineacorn Grain</i>		<i>Groundnut Kernels</i>
		<i>Light Mori</i>	<i>Short Kaura</i>	
1952	301	1,013	1,173	729
1953	430	603	1,144	754
1954	473	861	944	606
1955	402	926	946	510

CATTLE

The breeding policy at Samaru of grading Ndama and White Fulani Zebu crossbreds towards the pure Ndama and the pure Zebu type continues. Table 2 shows the average live weights for Ndama X Zebu half-breds and for three-quarter breds.

TABLE 2.—AVERAGE LIVeweIGHTS OF NDAMA X ZEBU HALFBREDS
AND THREE-QUARTERBREDS
Weights in Lb

<i>Age</i>	<i>Ndama X Zebu (Ndama X Zebu) X Ndama (Ndama X Zebu) X Zebu</i>					
	<i>Bulls</i>	<i>Heifers</i>	<i>Bulls</i>	<i>Heifers</i>	<i>Bulls</i>	<i>Heifers</i>
At birth ...	37	33	41	33	49	48
6 months ...	179	143	176	179	177	230
12 months ...	278	210	286	253	269	322
18 months ...	378	325	401	286	443	446
24 months ...	498	463	470	439	486	551

The health of the cattle has generally been good. The only losses during the year were four calves from various causes. Twenty-one calves were born during the year. Nine beasts were culled and two more were transferred to the other stations. Table 3 shows the strength of the herd on 31st March, 1956.

TABLE 3.—NO. OF CATTLE IN ZEBU-NDAMA HERD ON 31-3-56

<i>Class</i>	NZ x N	NZ x Z	NZ	Z	N	<i>Total</i>
Stock bulls ...	—	—	—	1	1	2
Cows ...	—	1	12	7	—	20
1-3yr. bulls ...	4	4	6	—	—	14
1-3yr. heifers ...	3	3	3	—	—	9
Bull calves ...	8	4	5	2	—	19
Heifer calves ...	4	5	8	—	—	17
Total ...	19	17	34	10	1	81
Total 31-3-55 ...	11	11	33	18	1	74

B.—EXPERIMENTS REPORT

GROUNDNUTS

(1) *Deterioration of Groundnut Seed, Daura.*—The experiment on the deterioration of introduced groundnut varieties at Daura was brought to a conclusion this year. As reported last year there have been strong indications that introduced groundnut varieties fall off very markedly in performance after the first season at Daura. The results for the three years of the trial are given in Table 4.

TABLE 4.—DETERIORATION OF GROUNDNUT SEED, DAURA

Type of Seed	Kernels			Haulms			Stand Count at Harvest per cent		
	1953 ***	1954 ***	1955 ***	1953	1954 ***	1955 ***	1953	1954	1955
Local spreading ...	843	637	1,030	—	414	1,142	91.7	72.1	61.7
New Castle Cary ex-Samaru ...	594	561	797	—	570	1,235	91.4	78.1	47.9
Old Castle Cary ...	—	323	636	—	312	1,019	—	30.8	30.5
Once grown Castle Cary	—	151	599	—	224	1,112	—	24.0	26.5
Twice grown Castle Cary	—	—	432	—	—	753	—	—	16.8
S. E. ...	±20	±33	±53	—	±25	±63	—	—	—

The results for the three years show that the local spreading variety is, in general, superior to the introduced new Castle Cary seed. In 1953 and 1954 there was no marked difference between the stand counts of the varieties. In 1955 all types showed very poor stand counts at harvest and there was a distinct difference between the local spreading variety and new Castle Cary seed indicating that the local variety stands up to adverse conditions rather better.

The results clearly show that there is a marked deterioration in the preformance of the variety Castle Cary after it has been grown one season at Daura compared to new seed introduced from Samaru each year. This deterioration is carried on in the second year. On the other hand the so-called Old Castle Cary which has been maintained at Daura for a good many years shows a marked improvement over once and twice grown seed. This would seem to indicate that a certain amount of natural selection has taken place and that the variety Castle Cary is gradually acclimatising itself to Daura conditions.

Germination counts indicate reduced viability of Castle Cary seed after being once or twice grown at Daura.

(2) *Dates of planting Groundnuts, Kontagora.*—An observation trial comparing different dates of planting groundnuts was carried out for the second year using the varieties S.38 and Kotonkoro. Plantings were carried out every second day from mid-April to the end of May. 1954 results showed that planting after the end of May gave no yield at all.

The results are presented in graph form for the two varieties (Fig. 1). For this particular season it would seem that the optimum time of planting was before 24th April.

(3) *Variety and Cultivation Trial, Maiduguri.*—A comparison of planting on the flat versus planting on the ridge was superimposed on a groundnut variety trial at Maiduguri.

The results are presented in Table 5.

TABLE 5.—VARIETY AND CULTIVATION TRIAL ON GROUNDNUTS
MAIDUGURI*Yields in lb. Kernels per acre*

Variety	Method of Cultivation	
	Flat	Ridge
	Not Significant	
ML 378	837	862
Daura local spreading ...	784	796
S 38	877	750
K 50	702	930
Maiduguri local spreading	779	866
S.E.	± 82	

There would appear to be a trend favouring growing on the ridge as compared to growing on the flat but the differences, as has been quite common with this comparison to date, are not significant.

(4) *Seed Dressing Trials on Groundnuts.*—Trials on the use of proprietary seed dressings on groundnuts were carried out at Samaru, Kano and Sokoto.

The figures for germination counts and yields of kernels are given in

TABLE 6.—SEED DRESSINGS ON GROUNDNUTS.—SAMARU
Germination counts as percentages, yields as lb. of kernels per acre

Treatment	Samaru		Kano		Sokoto	
	Germination	Kernels	Germination	Kernels	Germination	Kernels
		N.S.		N.S.		*
Fernasan A (0.2%)	98.54	1,509	89.31	1,166	78.86	783
Fernasan O (0.2%)	98.59	1,453	92.36	1,164	78.00	737
YF 3669 (0.2%)	98.54	1,592	88.96	1,150	77.14	795
YF 3734 (0.2%)	98.39	1,552	86.35	1,154	80.57	760
Control	98.39	1,517	83.44	1,143	70.86	582
S. E.	—	± 44	—	± 42	—	± 46

The only significant result obtained was at Sokoto where all the dressed seed treatments outyielded the control. The conditions at Sokoto were rather more adverse than at the other two stations.

GUINEACORN

(1) *Effect of Striga on Yield of Guineacorn.*—Investigation into the effect of the parasite *Striga senegalensis*, on the yield of guineacorn grown under different levels of fertility continued at Samaru and Yandev.

At Yandev the plots on which striga had been hand pulled for three years were changed over with the non-pulled plots to see whether the signi-

ificant increase produced by three years hand pulling could be confirmed as not due to chance.

The results at Yandev for 1954 and 1955 are given in Table 7.

TABLE 7.—EFFECT OF STRIGA ON GUINEACORN, YANDEV
lb. grain per acre and Striga counts per acre

<i>Treatment</i>	1955		1954	
	<i>Grain</i>	<i>Striga counts</i>	<i>Grain</i>	<i>Striga counts</i>
<i>Farmyard Manure:</i>	***		***	
10 tons per acre	367	30,324	800	75,965
3 tons per acre	123	29,463	459	77,549
Nil tons per acre	8	17,552	169	53,268
S.E.	± 25		± 53	
<i>Hand pulling of Striga:</i>	**	***	***	
Pulled	114	54,696	751	111,570
Not pulled	218	22,643	452	26,297
S.E.	± 38		± 38	

Interactions

1955 * *F.Y.M. X Hand Pulling*

<i>F.Y.M.</i>					<i>Pulled</i>	<i>Not pulled</i>
Nil					4	12
3 t.p.a.					84	162
10 t.p.a.					254	479
S.E. ± 35						
					1954	
Nil					196	142
3 t.p.a.					616	303
10 t.p.a.					971	629
S.E. ± 52						

The effects of the different levels of manure were the same for 1955 as in 1954, both 10 and 3 tons per acre giving significant increases in yield over no manure. However the yields at all levels of manure were much lower than in 1954.

The changing over of the hand pulled with the non-pulled plots has produced the very interesting result that for the first time in the four years of this experiment, the plots on which striga was not pulled have significantly outyielded the plots on which Striga has been pulled. This indicates that three years of hand pulling has noticeably reduced the Striga population, and this is borne out by the Striga counts which show only half as many

Striga plants on the non-pulled plots as on the pulled plots. This result is surprising in view of the small size of the plots, and the ease with which Striga seed can be dispersed.

On the 1955 results, considered in relation to previous years, it would seem that hand pulling over three years will substantially reduce the Striga population: pulling for one year only will not reduce the effects of Striga to a very great extent.

The manure versus hand pulling interaction is completely the reverse of that for 1954 due to the higher Striga populations in the pulled plots.

At Samaru, the trial aimed at separating the two effects, (a) reduction of yields due to monoculture and low fertility and (b) reduction of yields due to the direct effect of Striga parasitism, was continued. The grain yields and Striga counts for 1954 and 1955 are presented in Table 8.

TABLE 8.—EFFECT OF STRIGA ON GUINEACORN, SAMARU
lb. of grain per acre and Striga counts per acre

	1955		1954	
	<i>Grain</i>	<i>Striga counts</i>	<i>Grain</i>	<i>Striga counts</i>
<i>Farmyard Manure:</i>	***	N.S.	***	***
3 tons per acre	1190	4691	1072	8833
Nil	426	6505	321	4208
<i>Hand pulling of Striga:</i>	N.S.	N.S.	N.S.	N.S.
Pulled	799	5964	723	3188
Not pulled	816	5233	670	9853
<i>Striga infection:</i>	N.S.	**	*	***
Infected	826	8040	591	9466
Not infected	789	3156	802	3574
S.E.	±30	±1009	±55	±627

INTERACTION
F.Y.M. X Striga Infection

<i>Striga Infection</i>	<i>F.Y.M.</i>							
	1955				1954			
	<i>Nil</i>		<i>3 tons</i>		<i>Nil</i>		<i>3 tons</i>	
	<i>Grain (lbs)</i>	<i>Striga counts</i>	<i>Grain (lbs)</i>	<i>Striga counts</i>	<i>Grain (lbs)</i>	<i>Striga counts</i>	<i>Grain (lbs)</i>	<i>Striga counts</i>
Infected	438	10,338	1,214	5,743	293	6,053	889	12,880
Not Infected	414	2,673	1,163	3,640	349	2,363	1,254	4,785

The application of 3 tons per acre of farmyard manure has maintained reasonable yields, while the unmanured plots are reaching a satisfactory low level of yield. Unfortunately the infection of plots by the annual sowing of *Striga* seed has not yet produced populations of an order likely to have a marked effect in reducing yields, while (in spite of the fact that *Striga* is not allowed to seed in this trial) the populations on the non-infected plots are still higher than had been hoped.

(2) *Chemical control of Striga in Guinea-corn, Yandev.*—An experiment comparing spraying with Agroxone 4, hand pulling of *Striga* and transplanting of guinea-corn seedlings, as a means of controlling or avoiding the effects of *Striga*, was carried out at Yandev. The results, which were not significant, are given in Table 9.

TABLE 9. CONTROL OF STRIGA IN GUINEACORN, YANDEV
lb. of grain per acre

<i>Treatment</i>								<i>Grain</i>
								N.S.
Hand pulling ...	...	...	...	...	...	...	...	780
Agroxone 4 spray ...	...	...	...	...	...	...	...	746
Control ...	...	...	...	...	...	...	...	603
Transplanting ...	...	...	...	...	...	...	...	589
S.E. ...	...	...	...	...	...	...	...	±111

(Note: the coefficient of variation for this experiment was 46 per cent)

Another experiment at Badeggi comparing one and two sprayings of Agroxone 4 was a complete failure.

(3) *Times of Application of Phosphate to Guinea-corn.*—Trials were carried out at various stations to determine the period over which superphosphate may be applied to guinea-corn without loss in effectiveness.

Superphosphate was applied at the rate of 60 lbs. per acre in each case.

The results by stations are given in Table 10.

TABLE 10. TIMES OF APPLICATION OF PHOSPHATE TO GUINEACORN
lb. of grain per acre

<i>Treatment</i>	<i>Daudawa</i>		<i>Gusau</i>		<i>Kafinsoli</i> 1955	<i>Kano</i> 1954	<i>Comprised</i> <i>results</i>
	1955	1954	1955	1954			
<i>Superphosphate</i>	N.S.	*	N.S.	N.S.	N.S.	N.S.	**
Application at planting ...	1,232	1,569	611	649	564	955	930
Application at 2 leaf stage ...	1,308	1,595	597	672	646	1,126	991
Application at 4 leaf stage ...	1,346	1,542	514	799	593	1,153	991
Nil ...	1,213	1,264	526	600	531	884	836
S.E. ...	± 67	± 76	± 58	± 51	± 48	± 76	± 29

Only one significant result was obtained: at Daudawa in 1954, application of superphosphate at any of the three times was shown to be significantly better than no fertiliser. The lack of significant results between superphosphate versus no superphosphate can however be attributed to the lack of precision in the layouts of the experiments. The analysis of the combined results of all experiments shows a significant result in favour of superphosphate applied at the three stages over no superphosphate.

In no case is there any significant difference between the three times of application. The results indicate therefore that superphosphate may be applied to guineacorn at any time from planting to the 4 leaf stage without a drop in effectiveness as measured by yield increases.

(4) *Times of Application of Nitrogen and Phosphate to Guineacorn.*—Trials were carried out at Samaru, Zonkwa, Mokwa and Bida comparing the effects of applying sulphate of ammonia and superphosphate to guineacorn at planting, the 2 leaf stage and the 4 leaf stage.

Samaru.—No significant results were obtained. The experimental site had received dressings of farmyard manure every year for the last four years so the fertiliser effects were possibly masked by residual effects of the manure; yields were very good on all treatments.

Zonkwa.—The results are given in Table 11.

TABLE 11. TIMES OF APPLICATION OF NITROGEN AND PHOSPHATE TO GUINEACORN, ZONKWA

<i>lb. of grain per acre</i>								
<i>Treatment</i>								<i>Grain</i>
<i>Sulphate of Ammonia:</i>								N.S.
112 lbs per acre	...	...	...	...	...	...	...	417
56 lbs per acre	...	...	...	...	...	...	...	400
Nil	...	...	...	...	...	...	...	382
<i>Superphosphate:</i>								***
112 lbs per acre	...	...	...	...	...	...	...	484
56 lbs per acre	...	...	...	...	...	...	...	458
Nil	...	...	...	...	...	...	...	256
<i>Time of Application:</i>								***
At planting time	...	...	...	...	...	...	...	496
At 2 leaf stage	...	...	...	...	...	...	...	404
At 4 leaf stage	...	...	...	...	...	...	...	299
S.E.	...	...	...	...	...	...	...	±25

Application of superphosphate gave a highly significant increase in yield. Sulphate of ammonia produced no significant effects and there was no interaction between sulphate of ammonia and superphosphate.

Application of fertilisers at planting time was shown to be better than at the 2 leaf or 4 leaf stage.

There was no interaction between rate of phosphate dressing and time of application. The "significant interaction" shown by the formal analysis of variance is entirely due to the presence of the dummy treatments at the nil phosphate level.

Bida.—The results for Bida are given in Table 12.

TABLE 12.—TIME OF APPLICATION OF NITROGEN AND
PHOSPHATE TO GUINEACORN, BIDA
lb. of grain per acre

<i>Treatment</i>								<i>Grain</i> **
<i>Sulphate of Ammonia:</i>								
120 lbs per acre	...	...	...	...	...	...	...	720
60 lbs per acre	...	...	...	...	...	...	...	615
Nil	...	...	...	...	...	...	...	579
<i>Superphosphate:</i>								**
120 lbs per acre	...	...	...	...	...	...	...	659
60 lbs per acre	...	...	...	...	...	...	...	698
Nil	...	...	...	...	...	...	...	558
<i>Time of Application:</i>								**
At 2 leaf stage	...	...	...	...	...	...	...	671
At 4 leaf stage	...	...	...	...	...	...	...	689
Flowering	...	...	...	...	...	...	...	554
S.E.	...	...	...	...	...	...	...	±26

INTERACTIONS
Nitrogen x Phosphate

<i>Superphosphate</i>							<i>Nil</i>	<i>60 lbs</i>	<i>Sulphate of Ammonia</i> <i>120 lbs</i>
Nil	...	...	...	...	...	...	510	505	661
60	...	...	...	...	...	...	504	743	850
120	...	...	...	...	...	...	725	602	653

S.E. ±45

The results for Bida show significant increases in yield from applications of sulphate of ammonia and superphosphate. There is also a significant interaction between the two fertilisers; the maximum yield increase was obtained with 120 lb. of sulphate of ammonia +60 lb. superphosphate which was significantly better than all other treatments except 60 lb. of ammonia +60 lb. of superphosphate.

The effect of time of application showed that there was no difference between applying at the two leaf and the four leaf stage, but applying at flowering time resulted in loss of effect of the fertilisers. As in the Zonkwa trial a spurious significant interaction appears on formal analysis between rates of phosphate and time of application, due to dummy treatments.

Mokwa.—The results for Mokwa are given in Table 13.

TABLE 13.—TIMES OF APPLICATION OF NITROGEN AND
PHOSPHATE TO GUINEACORN, MOKWA
lb. of grain per acre

<i>Treatment</i>								<i>Grain</i>
<i>Sulphate of Ammonia:</i>								N.S.
112 lbs per acre	...	...	...	...	...	...	...	2,089
56 lbs per acre	...	...	...	...	...	...	...	2,028
Nil	...	...	...	...	...	...	...	1,978
<i>Superphosphate:</i>								N.S.
112 lbs per acre	...	...	...	...	...	...	...	2,113
56 lbs per acre	...	...	...	...	...	...	...	1,976
Nil	...	...	...	...	...	...	...	2,005
S.E.	...	...	...	...	...	...	...	±41
<i>Time of Application:</i>								*
At planting time	...	...	...	...	...	...	...	1,987
2 months after planting	...	...	...	...	...	...	...	2,077
S.E.	...	...	...	...	...	...	...	±27

INTERACTION
Nitrogen x Phosphate

<i>Superphosphate</i>								<i>Sulphate of ammonia</i>		
								<i>Nil</i>	<i>56 lbs</i>	<i>112 lbs</i>
Nil	...	...	...	...	...	...	...	1,846	2,087	2,083
56 lbs	...	...	...	...	...	...	...	1,844	2,035	2,048
112 lbs	...	...	...	...	...	...	...	2,242	1,961	2,136

S.E. ±71

Although there was a significant interaction between sulphate of ammonia and superphosphate, there was no obvious trend discernible. The yields of guineacorn were very high. *General*.—The results from Zonkwa and Bida indicate that superphosphate is best applied fairly early in the growing stage of guineacorn, up to the four leaf stage probably being satisfactory.

The Bida results show that the maximum yield is obtained from mixture of superphosphate and sulphate of ammonia on Bida farm. On this year's results nitrogen does not appear to be necessary for guineacorn on Zonkwa farm.

Control of Covered Smut (Sphacelotheca sorghi) on Guineacorn

Bauchi.—An observation trial was carried out at Bauchi to test the efficiency of a local method of controlling covered smut on guineacorn, against the standard practice of treating seed with copper carbonate dust.

The local method of control consists of treating the guineacorn seed with the powdered root bark of the shrub "jan saye" (*Trichilia emetica*). The results of the trial are given in Table 14.

TABLE 14.—CONTROL OF COVERED SMUT OF GUINEACORN, BAUCHI
No. of Smutted Heads; lb of Grain per acre

				<i>No. of Smutted Heads</i>			<i>Grain (lbs)</i>
				<i>Partly Smutted</i>	<i>Completely Smutted</i>	<i>Total</i>	
Copper carbonate	...	...	...	—	—	—	799
"Jansaye"	...	...	...	23	7	30	515
Control	...	...	...	38	40	78	580

The results show that copper carbonate has given complete control of covered smut. The local method has provided some measure of control of the disease compared to no treatment but is markedly inferior to copper carbonate.

Samaru.—An experiment was carried out to compare Fernasan A and Fernasan D with the standard seed dressing, copper carbonate, as methods of controlling covered smut.

Artificial inoculation of the guineacorn with smut spores was carried out but this was a failure and virtually no smut infection was observed on any of the treatments. The results are given in Table 15.

TABLE 15.—CONTROL OF COVERED SMUT OF GUINEACORN, SAMARU
lb. of Grain per Acre

<i>Treatment</i>				<i>Grain</i>
<i>Seed Dressing</i>				<i>N.S.</i>
Inoculated seed + Fernasan A	...	...	...	1,024
Inoculated seed + Fernasan D	...	...	...	989
Inoculated seed + Copper carbonate	...	...	...	1,072
Inoculated seed not dressed	...	...	...	1,024
Non-inoculated seed + gammexane	...	...	...	973
Non-inoculated seed (control)	...	...	...	970
S. E.	...	...	...	±37

No significant results were obtained.

(6) *Seed Dressing Trials on Guinea-corn.*—Trials comparing various dressings on guineacorn were carried out at Samaru, Kano and Sokoto.

Records were made of stand counts at germination as well as yields. The results are given in Table 16.

TABLE 16.—SEED DRESSINGS ON GUINEACORN
Germination Counts as percentages: lb. of Grain per Acre

<i>Treatment</i>	<i>Samaru</i>		<i>Kano</i>		<i>Sokoto</i>	
	<i>Germination</i>	<i>Grain</i>	<i>Germination</i>	<i>Grain</i>	<i>Germination</i>	<i>Grain</i>
<i>Seed dressing</i>	<i>Percent</i>	<i>N.S.</i>	<i>Percent</i>	<i>N.S.</i>	<i>Percent</i>	<i>N.S.</i>
Fernasan A (0.15%) ...	99.06	992	97.79	1,120	52.31	674
Fernasan D (0.3%) ...	99.48	917	98.70	917	55.27	514
Fernasan D (0.4%) ...	—	—	—	—	53.13	622
YF 3670 (0.2%) ...	99.84	1,026	98.03	1,114	—	—
YF 3760 (0.3%) ...	99.43	1,103	97.60	1,163	49.73	588
Control ...	97.29	1,036	98.79	910	44.64	536
S. E. ...	—	±50	—	±70	—	±48

Although no significant yield differences were obtained the germination counts for dressed seed are generally higher than with the untreated seed.

The trial at Sokoto where the guineacorn was planted under rather adverse conditions, shows a marked increase in germination in favour of the seed dressings compared to the non-treated control.

(7) *Effect of Seed Storage Methods on Germination and Yield of Guinea-corn, Samaru.*—A trial was carried out at Samaru comparing different methods of storing and treating grain from harvest to sowing the following season,

The Treatment tested were:—

- (a) Seed stored on head (this is the normal practice)
- (b) Seed stored on head and treated with Fernasan D before sowing.
- (c) Threshed seed stored in rumbu (usual practice with grain for consumption).
- (d) Threshed seed stored in rumbu and treated with Fernasan D before storage.

The results are given in Table 17.

TABLE 17.—SEED STORAGE OF GUINEACORN, SAMARU
Germination Counts as Percentage: lb. Grain per Acre

<i>Treatment</i>	<i>Germination</i>	<i>Grain</i>
STORAGE OF SEED	<i>Per cent</i>	*
(a) on head	85.09	796
(b) on head + Fernasan D	93.48	970
(c) Threshed Seed in rumbu	88.51	870
(d) Threshed Seed in rumbu + Fernasan D	91.30	850
S. E.	—	±36

Storage on head and dressing with Fernasan D before sowing gave significantly better yields than all the other treatments.

MILLET

(1) *Time of application of Phosphate to Millet, Daura.*—The effects of applying 60 lbs per acre of superphosphate at various times from sowing were compared with no fertiliser application. The results are given in Table 18.

TABLE 18.—TIMES OF APPLICATION OF PHOSPHATE TO MILLET, DAURA
lb. Grain per Acre

<i>Treatment</i>	<i>Grain</i>
<i>Superphosphate</i>	**
Applied at planting	330
Applied at 2 leaf stage	376
Applied at 4 leaf stage	321
Nil	269
S. E.	±20

Yields were very low in all treatments but superphosphate applied at all three times gave significant increases in yield over no superphosphate.

There was no significant difference between the three times of application showing that there is a fairly long period during which superphosphate may be applied to millet.

An experiment at Sokoto, testing different rates of superphosphate applied at different times, failed completely.

(2) *Seed Dressing Trials on Millet*.—The effect of various seed dressings on germination and yield of millet was tested at Samaru, Kano and Sokoto. The results are given in Table 19.

TABLE 19.—SEED DRESSINGS ON MILLET
Germination as Per cent: lb. Grain per Acre

<i>Treatment</i>	<i>Samaru</i>		<i>Kano</i>		<i>Sokoto</i>	
	<i>Germination</i>	<i>Grain</i>	<i>Germination</i>	<i>Grain</i>	<i>Germination</i>	<i>Grain</i>
<i>Seed Dressing</i>	<i>Percent</i>	<i>N.S.</i>	<i>Percent</i>	<i>*</i>	<i>Percent</i>	<i>*</i>
Fernasan A (0.15%) ...	97.50	834	97.81	699	85.24	579
Fernasan D (0.3%) ...	99.48	838	98.85	809	87.14	510
Fernasan D (0.4%) ...	—	—	—	—	89.05	618
YF 3670 (0.2%) ...	99.58	854	99.17	645	—	—
YF 3760 (0.3%) ...	99.06	851	98.85	691	90.60	544
Control ...	95.00	857	99.38	594	60.36	283
S.E. ...	—	±23	—	±42	—	±71

The results at Sokoto, and to a lesser extent at Samaru, indicate improved germination of millet that has been treated.

At Kano and Sokoto significant increases in yield were obtained with treated seed. The Kano results show that Fernasan D was significantly better than the control or YF 3670. At Sokoto all the seed dressings gave significant increases in yield over the non-treated seed.

The yield of millet at Samaru was very good and the high level of fertility and optimum growing conditions probably tended to mask any effects of the seed dressings.

COWPEAS

(1) *Spacing of Cowpeas*.—A comparison of different spacings was superimposed on cowpea variety trials at Kafinsoli and Yandev.

At Kafinsoli the varieties were spaced at 2 feet and 1½ feet on 3 feet ridges interplanted through millet at 6 feet spacing.

At Yandev the varieties were spaced at 2 feet and 16 inches on 4 feet ridges interplanted through yams at 4 feet spacing.

The results for both stations are given in Table 20.

TABLE 20.—COWPEA VARIETY AND SPACING: KAFINSOLI AND YANDEV
lb. Threshed Seed per Acre

<i>Treatment</i>							<i>Kafinsoli</i>	<i>Yandev</i>
<i>Variety</i>							***	***
Mauritius	...	...	...	...	...	...	211	211
New Era	...	...	...	...	...	...	201	220
Local	...	...	...	...	...	...	101	381
S.E.	...	...	...	...	...	...	±14	±23
<i>Spacing</i>							N.S.	N.S.
Close	...	...	...	...	...	...	182	269
Wide	...	...	...	...	...	...	160	272
S.E.	...	...	...	...	...	...	±11	±19

At Kafinsoli the two introduced varieties were significantly better than the local variety, while at Yandev the reverse was true, the local variety significantly outyielding both the introductions.

At neither station were the spacings or the variety X spacing interactions significant. At Yandev in 1954, the variety Mauritius at close spacing was significantly better than all the other varieties at all spacings.

SOYA BEANS

(1) *Dates of planting Soya Beans, Kontagora*.—An observation trial was carried out at Kontagora to determine the optimum date of planting for soya beans using forty planting dates between 18th May and 14th July. The results are shown in Figure 2.

The earlier planting dates gave by far the best yields, there was a very rapid decline in yield from mid-June onwards. Plantings could not be carried out after 14th July, due to shortage of land.

ROTATIONS

(1) *Monocropping vs Rotation, Bida*.—A comparison of the yields of cassava, guineacorn and groundnuts grown as sole crops year after year, and in rotation with each other, completed its second and final three-year cycle at Bida.

The actual treatments tested in a factorial layout were:—

Cropping System

- (i) Monocropping
- (ii) Rotational cropping (Guineacorn–Groundnuts–Cassava).

Farmyard Manure

- (i) Nil
- (ii) 1 ton per acre annually.
- (iii) 3 tons per acre annually.
- (iv) 5 tons per acre annually.

The results for the first and second cycles are given in Table 21.

TABLE 21.—MONOCROPPING VERSUS ROTATION, BIDA
Yields in lb. per Acre per Annum of Guineacorn Grain, Groundnut Kernels
and Cassava Tubers

Treatment	Cycle					
	Second Cycle 1953-55			First Cycle 1950-52		
	G'corn	G'nuts	Cassava	G'corn	G'nuts	Cassava
Cropping System...	**	N.S.	**	**	N.S.	*
Monocropping ...	354	128	3,790	315	272	4,544
Rotation ...	668	162	4,724	624	346	5,405
S.E. ...	±50	±17	±125	±57	±32	±277
Farmyard Manure	***	*	***	**	N.S.	***
Nil ...	108	108	745	199	335	2,360
1 ton per acre ...	323	127	3,202	343	286	3,925
3 ton per acre ...	683	127	5,690	631	284	6,557
5 ton per acre ...	930	218	7,391	705	331	6,755
S.E. ...	±71	±23	±177	±80	±45	±356

Monocropping vs Rotation.—Monocropping significantly reduced the yield of both guineacorn and cassava in both cycles. Groundnuts showed no deleterious effects from monoculture but the yields of the two treatments were low in both cycles.

Manure.—(1) *Guineacorn.*—The application of three tons per acre of f.y.m. appears to give the optimum increase in yield although in 1955 five tons was significantly better than three tons.

(2) *Groundnuts.*—The application of five tons was significantly better than the lower rates of application or no manure in 1955. However, the yields were so low on all treatments as to make the result of little value.

(3) *Cassava.*—Application of f.y.m. to cassava produced very significant increases in yield. In 1952 the optimum rate was three tons per acre, while in 1955, five tons gave a highly significant increase over three tons.

Cropping System X Manure Interactions.—No interactions significant in either year. The differences between the two cycles for the two cropping systems are given in Table 22.

TABLE 22.—MONOCROPPING VERSUS ROTATION, COMPARISON OF
CYCLES, BIDA
Yield Differences in lb. per Acre

Treatment	Crop		
	G'corn grain	G'nut kernels	Cassava tubers
Cropping System	N.S.	N.S.	N.S.
Monocropping ...	+39	—144	—755
Rotation ...	+44	—184	—681
S.E. ...	—26.7	±20.4	±156

The figures show that the yields during the second cycle were lower than those during the first for both groundnuts and cassava. The drop is greater for monoculture with cassava, but greater for rotational cropping with groundnuts, but none of the differences is significant.

With guineacorn the second cycle proved higher yielding (N.S.) than the first; rotational cropping gave slightly the larger increase.

It is not possible to say how much of this difference is due to seasonal influence but the fact that different crops have given differences of opposite sign is noteworthy. All the above effects are, of course, averages over a series of manurial levels. The separate yields from these different manurial levels show that the differences between different systems of cropping are highly dependent on the level of manuring in the case of both cassava and guineacorn. This is brought out by the results of Table 23.

TABLE 23.—MONOCROPPING *Vs* ROTATION. EFFECTS OF MANURE LEVELS
Differences in total yield; second cycle minus first cycle
Yield differences in lb. per acre

Treatment	Guineacorn (grain)			Groundnuts (kernels)			Cassava (tubers)		
	Mono	Rota.	Mean	Mono	Rota.	Mean	Mono	Rota.	Mean
<i>Farmyard manure</i>	**		**	N.S.		N.S.	**	*	***
Nil ...	—109	—72	—91	—242	—211	—227	—1,355	—1,876	—1,616
1 ton/acre ...	—7	—34	—21	—174	—144	—159	—1,061	—389	—725
3 ton/acre ...	+69	+35	+52	—66	—247	—157	—1,187	—1,148	—1,168
5 ton/acre ...	+202	+247	+225	—92	—132	—112	+585	+686	+636
S.E. ...	±53.4		±37.7	±40.8		±28.8	±312		±221

The effect of level of manuring on the difference in yield given during the two separate cycles (*i.e.* the interaction of manure with cycle) is displayed by the figures given under the headings "Means"; it is highly significant for both guineacorn and cassava. The interaction of this effect with system of cropping (*i.e.* the second order interaction (manure x cycle x system of cropping)), is not significant. The figures in the body of the table show no consistent trends.

Monocropping Vs Rotation, Samaru.—This experiment which is similar to the Bida trial, reached the end of its second cycle this year.

The object of the trial is to compare the effects of monocropping and rotational cropping of the crops guineacorn, groundnuts and cotton. The effect of various levels of farmyard manure on the cropping systems and the crops were also tested.

The treatments tested in a factorial layout are:

A. *Cropping System:*

(i) Monocropping.

(ii) Rotational Cropping (Guineacorn, Groundnuts, Cotton).

B. Farmyard Manure:

- (i) Nil.
- (ii) 1 ton per acre per annum.
- (iii) 3 tons per acre per annum.
- (iv) 5 tons per acre per annum.

The figures for the first and second cycles are given in Table 24.

TABLE 24.—MONOCROPPING VS ROTATIONS, SAMARU
Yield in lb. per acre per annum of guineacorn,
groundnut kernels and seed cotton.

	Cycle					
	Second Cycle 1955			First Cycle 1952		
	G'corn grain	G'nut Kernels	Seed Cotton	G'corn Grain	G'nut Kernels	Seed Cotton
<i>Cropping System</i>	**	*	N.S.	**	***	N.S.
Monocropping ...	947	781	402	939	717	420
Rotation ...	1,124	1,027	489	1,196	1,035	444
S.E. ...	±30	±58	±36	±49	±38	±24
<i>Farmyard Manure</i>	***	***	**	***	***	***
Nil ...	340	435	222	571	542	249
1 ton/acre ...	876	745	368	770	801	339
3 ton/acre ...	1,399	1,130	531	1,337	1,030	554
5 ton/acre ...	1,528	1,305	660	1,592	1,131	587
S.E. ...		±82	±51	±70	±53	±34

Monocropping Vs Rotation.—Both guineacorn and groundnuts show significant decreases in yield from monocropping in both cycles. The effect on guineacorn was no more marked in the second cycle than in the first but with groundnuts the effect was much greater in the first cycle than in the second. At Bida (where yields were much lower) there was no significant difference between groundnuts grown as a sole crop or in rotation.

Cotton in neither cycle showed any significant response to cropping systems, but this was due to an interaction between cropping system and manure, whereby at low levels of manure rotation gave higher yields, but at high rates (possibly due to excessive vegetative growth on rotated plots) monocropping gave higher yields.

Manure.—Farmyard manure at all rates on all three crops produced significant increases in yield over no manure. The optimum rate of application for all crops would seem to be 3 tons per acre. Only in the case of guineacorn in 1952 was 5 tons per acre significantly better than 3 tons per acre.

The differences between the two cycles for the two cropping systems are given in Table 25.

TABLE 25.—MONOCROPPING *Vs* ROTATION, COMPARISON OF CYCLES,
SAMARU

Yield differences in lb. per acre

<i>Treatment</i>	<i>Crop</i>		
	<i>Guineacorn grain</i>	<i>Groundnut kernels</i>	<i>Cotton</i>
<i>Cropping System:</i>			
Monocropping ...	—298	—139	—148
Rotation ...	—214	—255	—42

The figures given in Table 25 show that yields during the second cycle were lower for all the three crops than in the first cycle. The drop is greater for monocropping in the case of guineacorn and cotton; with groundnuts the drop is greater for rotational cropping. These figures are based on only one replication so that no statistical analysis was possible.

As at Bida, it is not possible to say how much of this decline in yield is due to seasonal effects but the depression of yield of all crops in the second cycle compared to the first is most marked with both cropping systems except in the case of cotton in rotation.

The effect of the different manurial levels is brought out in Table 26. Examination of the figures shows that the effect of manure application is to reduce the decline in yield from the first cycle to the second cycle and, in a few cases, to give an increase in yield in the second cycle compared to the first.

There does not appear to be any marked difference between cropping system x manurial levels x cycle except in the case of cotton when the response to manure is greater under rotation in the second cycle than under monocropping.

TABLE 26.—MONOCROPPING *Vs* ROTATION. EFFECTS OF MANURIAL
LEVELS ON CROPPING SYSTEM, SAMARU

Differences in total yield; second cycle minus first cycle
Yield differences in lb. per acre

<i>Treatment</i>	<i>Guineacorn (grain)</i>			<i>Groundnuts (kernels)</i>			<i>Seed Cotton</i>		
	<i>Mono</i>	<i>Rota.</i>	<i>Mean</i>	<i>Mono</i>	<i>Rota.</i>	<i>Mean</i>	<i>Mono.</i>	<i>Rota.</i>	<i>Mean</i>
<i>Farmyard Manure</i>									
Nil ...	—589	—512	—551	—297	—489	—393	—144	—215	—180
1 ton/acre ...	—264	—66	—165	—377	—398	—388	—114	—176	—145
3 ton/acre ...	+9	—110	—51	—51	—70	—61	—331	+14	—89
5 ton/acre ...	—345	—169	—257	+211	?64	±74	—3	+569	+33

The interaction of manure with cycle as displayed by the figures given under the heading "Mean" is most marked for Groundnuts and Cotton.

FALLOWS

(1) *Types of Fallow, Bauchi*.—Two fallow experiments completed cycles at Bauchi this year.

(a) *Three-Year Fallows*.—Three-year fallows were compared with a three-year rotation plus manure.

The Fallows tested were:

- | | | | | |
|----------------------------------|-----|-----|-----------|---------------|
| (i) <i>Andropogon gayanus</i> | ... | ... | (Gamba) | } Three years |
| (ii) <i>Pennisetum spp.</i> | ... | ... | (Kyasawa) | |
| (iii) <i>Stylobium aterrimum</i> | ... | ... | (Mucuna) | |

The Rotation used was:

Guineacorn plus 3 tons of F.Y.M.

Cotton

Groundnuts.

The test crop used in 1955 was groundnuts and the results for 1955 and 1953 (when the test crop was cotton) are given in Table 27.

TABLE 27.—TYPES OF THREE-YEAR FALLOW, BAUCHI
lb. per acre

<i>Treatment</i>	1955	1953
	<i>Groundnut kernels</i>	<i>Seed Cotton</i>
<i>Types of Fallow</i>	N.S.	N.S.
Gamba	922	210
Kyasawa	831	235
Mucuna	855	219
Rotation + F.Y.M.	849	191
S.E.	±43	±10

No significant results were obtained in either year which would seem to indicate that three-year fallows of Gamba, Kyasawa and Mucuna are equivalent to each other in fertility maintenance, but that the same rather mediocre level of fertility can be equally well maintained by continuing the arable rotation and supplying 3 tons of manure per acre.

(b) *Four-Year Fallows*.—Four-year fallows were compared with a four-year rotation plus manure.

The Fallows tested were:

- | | |
|---------------------|--------------|
| (i) <i>Gamba</i> | } Four years |
| (ii) <i>Kyasawa</i> | |
| (iii) <i>Mucuna</i> | |

The Rotation used was:

Guineacorn plus 3 tons of F.Y.M. per acre.

Cotton

Millet and Cowpeas
Groundnuts.

The test crop used was guineacorn. The results are given in Table 28.

TABLE 28.—TYPES OF FOUR-YEAR FALLOW, BAUCHI
lb. per acre of guineacorn grain

<i>Treatment</i>					<i>Guineacorn grain</i>
<i>Types of Fallow</i>	...	...	...	...	N.S.
Gamba	...	...	...	...	641
Kyasawa	...	...	...	...	549
Mucuna	...	...	...	...	685
Rotation	F.Y.M.	...	...	...	583
S.E.	...	...	...	...	±54

No significant results were obtained. The indications would appear to be that the three types of fallow are equivalent in soil fertility maintenance or restoration value and that they are no better and no worse from the soil fertility point of view than a four-course rotation plus farmyard manure. The level of fertility is again extremely low.

General.—The results of both these trials to date show that, from the short term view at least, fallowing is not an economic proposition and that maximum returns would be obtained from crops grown in rotation, either three-course or four-course, with 3 tons of farmyard manure applied to the grain crop.

(2) *Fallow and Rotation Observations, Sokoto.*—Two observation trials, one on so-called good land and one on poor land were started at Sokoto in 1951 to test the possibility on this very poor land where arable crop yields are low, of using grass rather than arable crops as a source of cash income to the local farmers, the grass and hay to be fed to the farmers' cattle, and surplus hay sold (hay being a saleable product in Sokoto town).

The cropping plan was five years grass and three years food crops (farmers' subsistence) and the calculated available farmyard manure was applied to guineacorn and millet (first year), millet and cowpeas (second year) at 2 tons per acre, groundnuts (third year) and the grass ley received no manure.

Yields of food crops and grass on both sites have been so low in spite of the applications of manure that the trials have been abandoned. No conclusions can be drawn from the results.

MANURES

(1) *Permanent Manurial Demonstration, Kano*.—Millet and groundnuts have been cropped continuously on the same land since 1931 with no manure and three tons of farmyard manure per acre annually.

The results for 1955 are given in Table 29.

TABLE 29.—PERMANENT MANURIAL DEMONSTRATION, KANO

Yields in lb. of Threshed Seed per Acre

<i>Treatment</i>	<i>Millet</i>	<i>Groundnuts</i>
<i>Farmyard Manure</i>	<i>Sig.</i>	<i>Sig.</i>
3 tons per acre per annum	715	825
Nil	444	460
S.E.	±34	±53

The unmanured millet yields showed a considerable increase over last year. The unmanured groundnut plots have continued to maintain yield surprisingly well.

The manured millet and groundnut plots have maintained their yield, and the figures (representing twenty-five years' monoculture) are considered quite remarkable.

(2) *Restoration and Maintenance of Fertility, Kano*.—A trial was continued to find the best method of restoring fertility on land previously cropped with guineacorn without manure for nineteen years, where yields had dropped almost to "nil".

Various manurial treatments have now been applied for six years to the guineacorn crop.

The results for the period 1950-1955 are given in Table 30.

TABLE 30.—RESTORATION OF FERTILITY, KANO

lb. of Guineacorn Grain per Acre

<i>Treatment</i>	1955	1954	1953	1952	1951	1950
<i>Rate per acre</i>	<i>Not analysed</i>	<i>Not analysed</i>	***	***	***	***
3 tons F.Y.M.	157	482	372	491	616	247
75 lbs N, 150 lbs P + 50 lbs K ...	2	6	175	205	450	33
75 lbs N	2	3	106	155	266	7
150 lbs P... ..	2	5	91	207	389	36
50 lbs K	2	3	81	173	321	8
Nil	1	8	66	133	272	4
S.E.	—	—	±31	±14	±34	±14

(N=Sulphate of ammonia; P=Superphosphate; K=Murate of potash).

Once again the guineacorn on all treatments, except three tons per acre of F.Y.M., failed. It is now fairly obvious that restoration of fertility is not

being achieved. As the monocropping of guineacorn is possibly a factor in this experiment it has been decided to use millet as the test crop in 1956.

The complementary trial at Kano is designed to investigate the rate at which fertility will fall with reduced manurial dressings on land previously cropped with guineacorn, with manure for nineteen years. The results for the period 1950-55 are given in Table 31.

TABLE 31.—MAINTENANCE OF FERTILITY, KANO
lb. of Guineacorn Grain per Acre

<i>Treatments</i>	1955	1954	1953	1952	1951	1950
<i>Farmyard Manure per acre</i>	***	***	***	**	N.S.	*
3 tons annually	299	783	893	1,053	974	816
2 tons annually	162	543	818	683	986	665
1 ton annually	224	398	670	799	918	608
3 tons every third year	115	364	776	979	1,032	828
2 tons every third year	68	261	626	876	829	693
Nil	22	76	330	584	813	539
S.E.	±33	±54	±67	±52	—	±66

(Note.—The applications of F.Y.M. every third year were applied in 1950 and 1953).

The yields of all treatments dropped very sharply this year; in the case of the plots receiving farmyard manure every third year the drop was to be expected as it is three years since the last application. The reason for the decline in yield of the plots receiving manure every year is not clear; comparable non-experimental yields of guineacorn on Kano farm were about 900 lbs per acre.

A noteworthy feature of these two trials is that, in spite of twenty-five years monoculture, Striga, though present is by no means a heavy infestation.

(3) *Rates of farmyard manure in Continuous Cropping, Yandev.*—As reported last year, an experiment was conducted at Yandev from 1940 to 1951, to find the optimum rate of application of farmyard manure to a rotation of grain, benniseed and yams. The manurial rates were one, two and three tons per acre of farmyard manure applied to the grain crop only. It was found that the plots receiving one ton per acre were declining in fertility; two tons per acre plots maintained fertility, while the three tons per acre plots were gradually improving in fertility.

In 1952 the treatments were changed as follows:

- A Increase 1 ton to 1½ tons.
- B Increase 2 tons to 3 tons.
- C Decrease 3 tons to nil.

The results for the first year of the second cycle are given in Table 32 with yields for 1952 for comparative purposes.

TABLE 32.—CONTINUOUS CROPPING WITH F.Y.M., YANDEV
Yields in lb. per Acre of Threshed Grain (Millet plus Guineacorn)

Treatments							1955	1952
							<i>Sig.</i>	<i>N.S.</i>
A	...	...	...	...	...	...	347	728
B	...	...	...	...	...	...	517	938
C	...	...	...	...	...	...	210	870
S.E.	...	...	...	...	...	...	—	—

The results for 1955 show that it has taken only four years of rotational cropping to reduce the residual fertility from the application of three tons per acre of F.Y.M. every three years over a period of eleven years. It is still too early to say anything about the effect of the increase of the manurial levels on the other two treatments. The yields were poor even on the best treatment.

(4) *Night Soil Compost, Samaru.*—For the third year the value of night soil compost was compared with that of farmyard manure. The residual effects of the 1954 trial were also measured. The results are given in Table 33.

TABLE 33.—NIGHT SOIL COMPOST *Vs* FARMYARD MANURE

Treatment				1955	1954	1953	Residual effect of 1954 in 1955
				<i>G'corn</i>	<i>G'corn</i>	<i>G'corn</i>	<i>G'nuts</i>
3 tons F.Y.M.	...	...	...	1,676	1,453	1,642	1,005
6 tons Compost	...	...	...	1,558	1,176	1,605	1,220
3 tons Compost	...	...	...	1,527	1,020	1,533	1,069
Nil	...	...	...	1,268	602	941	873
S.E.	...	...	...	±69	±115	±105	±34

The results this year again show no difference between the three manurial treatments which were all significantly better than no manure.

The residual effects of the 1954 applications were quite marked; all manurial treatments still being significantly better than no manure. The six tons of compost showed a significantly greater residual effect than either the three tons of F.Y.M. or the three tons of compost; the effects for these were not significantly different from each other.

CULTIVATIONS

(1) *Hilling versus Ridging, Bida.*—The object of this experiment is to compare over a period yields from standard departmental three foot ridges with yields from 4½-foot ridges and hill planting, both of which are commonly used by local farmers.

The plant populations were the same for the three treatments. The results for 1955 (test crop, groundnuts) and for 1954 (test crop, guineacorn) are given in Table 34.

TABLE 34.—HILLING *Vs* RIDGING, BIDA
lb. per Acre of Groundnut Kernels; Guineacorn Grain

<i>Cultivation Method</i>						1955 <i>G'nut</i> <i>Kernels</i>	1954 <i>G'corn</i> <i>grain</i>
						**	N.S.
3-foot ridges ...	...	...	...	...	...	423	242
4½-foot ridges	...	...	...	...	...	321	247
Hills ...	...	...	...	...	...	287	215
S.E. ...	...	...	...	...	...	±23	±20

The standard 3-foot ridges used by the Agricultural Department gave a significantly higher yield of groundnuts than either the wider spaced native ridges or the hills; these two treatments did not differ significantly.

The yields on all treatments were low.

WEED CONTROL

(1) *Control of cynodon dactylon, Samaru.*—As reported last year three chemical treatments were superimposed on dry season disc ploughing of land infected with *Cynodon Dactylon* to determine their effectiveness in controlling this weed.

The Treatments used and rates were as follows:

C.M.U. at 20, 40, and 60 lb. per acre.

P.D.U. at 20, 40, and 60 lb. per acre.

Sodium trichloracetate at 50, 100 and 150 lb. per acre.

The residual effects of these treatments were tested using cotton which was planted eight to nine months after the application of the chemicals. Three plantings were attempted on 25-6-55, 13-7-55 and 9-8-55.

Residual effects on the first sowing of cotton were very marked and these effects persisted into the two later sowings. Sodium trichloracetate showed the least effects and there were indications that its harmful effects on germination were gradually being reduced. However *Cynodon Dactylon* was reappearing on the sodium trichloracetate plots.

The plots which received C.M.U. at 60 lbs. per acre allowed practically no growth of cotton plants and the *C. dactylon* was almost completely eradicated.

P.D.U. showed less residual effect on cotton than C.M.U. but the control of *C. dactylon* was poor.

The results obtained indicate that: Sodium thrichloracetate at 100 lbs. per acre could be used for control of *C. dactylon* in conjunction with cultivation treatments but the cost would be prohibitive. The land would also be lost to cropping for one year due to the residual effects of the chemical. The grass begins to re-establish itself after eight to nine months. C.M.U. gives

complete control at 60 lbs. per acre but the residual effects are very marked after eight months. This chemical is much slower acting than the other two, but is much more persistent. P.D.U. gives only limited control of the grass; residual effect on cotton is not as pronounced as C.M.U.

Dry season ploughing with a Ransome's 'Durotrac' plough was again tried at the end of the rains and was followed by a further ploughing with a Ransome's 'Solotrac' towards the end of the dry season; it is still too early to say what effect this has had on the weed.

BOTANY AND PLANT PATHOLOGY SECTION

BY A. R. MAURER, ELIZABETH HARRISON, D. L. CURTIS R. E. WYATT,
D. G. FARIES, C. W. MORGAN AND W. R. WILSON

A. GENERAL—(A. R. MAURER)

During the past year the Senior Staff position of this section has improved greatly and the staff now consists of five Botanists, two Plant Pathologists and one Specialist Assistant.

With this increase in staff it has been possible to make plans for expansion in the work on Plant Breeding and Plant Pathology. Particular emphasis is being placed on Nigerian food crops while the work on export crops, particularly groundnuts and soya beans, is also being enlarged.

The completion of the glass-house rendered possible a start on controlled pot experiments and hybridization of several crops. A soil sterilizing and potting building has also been constructed and this will soon be in use. Air-conditioning equipment is on order for the plant-growth chamber while all other fixtures for it have been received. The use of this room will considerably speed-up the groundnut hybridization programme.

The laboratory and laboratory work-shops are now well equipped and are in constant use. A limiting factor now is the lack of space in the main building and the construction of the projected new laboratory and office block is an urgent necessity.

At Kano an extension of 133 acres to Kano Farm has been acquired and will be used for groundnut breeding and multiplication work. The land is inside the Government Residential Area and constitutes part of the building free zone. Tall crops are precluded within the area by the medical authorities and a rotation is being worked out accordingly. The area has been surveyed and is being brought into cultivation in 1956. The multiplication of standard varieties and some selection will be carried out on the arable blocks. Much of the land is more suitable to pasture and this will be used in the maintenance of the Kano herd. The area has been fenced and the main arable blocks cleared. The function of the extended Kano farm as a groundnut research sub-station is being fully integrated with its function of experimentation in other crops.

B. GROUNDNUTS (ARACHIS HYPOGAEA)—(C. W. MORGAN)

The season 1955 has been a particularly good one for groundnuts. A record crop was produced by the farmers while at Samaru and at many

outstations yields of over 1,000 lbs. of kernels per acre were common. Work for the season continued along lines similar to those of previous years.

1. BREEDING

(a) *Introductions*.—Once again groundnuts have come in from all over the world and have comprised not only the tetraploid *Arachis hypogaea* but also the diploid species *A. pusilla* and *A. villosa*. Varieties were obtained from Sierra Leone, from Bambey in French Senegal, from Leningrad in Soviet Russia and from Florida in the United States of America. The Premier of the Northern Region brought four varieties from Tripoli on his way back to Nigeria, while thirty-four varieties and selections were obtained from Tarna Agricultural Station in French Niger Territory. These last mentioned groundnuts have already been distributed for testing to stations along the northern border of the region, Sokoto, Daura and Maiduguri.

(b) *Selection*.—This work has continued along the same lines as laid down in previous years. It has however been decided to cull more severely in future, so only the very best material is retained.

A block consisting of selections for Rosette resistance from the East African variety Mwitunde was laid down at Samaru. Rosette was, however, not severe this year, and no rosetted plants were found in this block. A number of selections for yield were made, and these will be bulked for further testing next year.

(c) *Hybridization*.—Multiplication of established hybrids and production of new ones has continued. A number of crosses made during the months of December and January all failed. This was presumably due to the effect of the harmattan which dried out the pollen grains before they were able to germinate. Correspondence with other countries including the United States and Soviet Russia has shown that their hybridization techniques do not differ markedly from ours. With the arrival of the lighting equipment it is hoped that in the near future the physiological control room will be in operation, in which, besides other photoperiodic studies, it is hoped to turn night into day and so greatly facilitate the work of the hybridization programme.

In the multiplication of hybrids, interesting varieties such as albinos have been observed in F₂ and F₃ segregations. A cross between M'Foko and American White has produced in the F₃ a whitekerneled nut of the Castle Cary type. It was hoped that provided the yield was satisfactory, a start at least had been made towards the production of a strain suitable for artificial fibre production that could be grown widely in the North. Much of the significance of this work has now disappeared as it is learned that the firm concerned is not prepared to pay a premium for groundnuts with a white testa.

2. VARIETY TRIALS

Trials have been conducted at Samaru and at many outstations with the object of either, finding a better variety for the particular area than the one already recommended, or of finding a variety better than the local one.

Broadly speaking, it has been found in the past that a short season variety such as Spanish 205, is best suited to the Southern Guinea Savannah stations such as Yandev; for the Northern Guinea Zone as typified by Samaru, either Castle Cary or Samaru 38 and for the immediate area of Kano, Kano 50. A variety to consistently outyield the locals such as Daura local spreading has yet to be found for the Sudan Zone and this aspect is receiving special attention at the moment.

A—TRIALS AT SAMARU

Main Variety Trial.—This trial has continued in one form or another since 1946 and results are shown in Table 35. Varieties have again shown their readiness to vary radically from year to year. 14-T-12 has done well in its first year after showing promise last season in the second variety trial. Mache Atsugune has failed again to live up to its promise of 1953 when first introduced.

TABLE 35.—SAMARU MAIN VARIETY TRIAL

<i>Year</i>	1953	1954	1955	1955	1946-55
<i>No. of Varieties</i>	15	15	15	*** <i>shellednuts</i>	<i>Average yield</i>
14 T 12	—	—	2	1,219	(1,219)
MG 371	8	1	8	1,104	1,195
Castle Cary	9	2	5	1,181	1,183
MK 374	1	11	4	1,188	1,149
L 234	—	12	1	1,289	1,132
MJ 371	13	7	8	1,104	1,103
MK 383	4	13	7	1,109	1,102
Kano 50	5	14	6	1,129	1,101
L 250	—	3	12	1,070	1,093
L 245	—	4	10	1,092	1,093
L 235	—	10	3	1,193	1,089
Samaru 38	12	5	14	924	1,083
MJ 374	10	8	13	997	1,077
L 60	—	9	11	1,072	1,031
Mache Atsugune ...	2	15	15	578	1,015
S.E.	—	—	—	±86	—

Columns 2-4 show relative positions in the year named.

Columns 5 and 6 show yields in lb. kernels per acre.

Groundnut Variety Trial II.—The trial this year was headed by two L strains. Table 36 shows a summary of yields in lb. kernels per acre. The variety Mwitunde which was said to possess a certain field resistance to rosette again proved to be a disappointing yielder at Samaru where rosette disease this year hardly occurred at all. The variety may yet prove

its worth in the Middle Belt where for example at Kontagora up to 90 per cent of the groundnuts at the farm were affected. Selection from non-affected plants of Mwitunde were made and these will be put into progeny rows for further observation next year at Kontagora.

TABLE 36.—SAMARU VARIETY TRIAL II

<i>Varieties</i>						1955 * <i>lb. kernels per acre</i>	1954 N.S.
L 258	...	...	...	...	...	1,200	690 (5)
L 200	...	...	...	...	...	1,188	768 (1)
MU 537A	...	...	...	...	...	1,162	—
Mache Atsugune	...	...	...	...	...	1,156	597 (10=)
L 121	...	...	...	...	...	1,151	683 (6)
S 38	...	...	...	...	...	1,151	597 (10=)
L 126	...	...	...	...	...	1,145	658 (7)
Castle Cary	...	...	...	...	...	1,120	740 (3)
Castle Cary ex Bida	...	...	...	...	...	1,097	612 (8)
15A 167	...	...	...	...	...	1,079	665 (7)
Mwitunde	...	...	...	...	...	1,068	691 (4)
18B 138	...	...	...	...	...	996	755 (2)
WU 531B	...	...	...	...	...	847	—
S.E.	...	...	...	...	...	±85	±88

Figures in brackets in the last column indicate the relative positions of the varieties in 1954.

New Selections Trial.—Selections that do consistently well in this trial move up to the second variety trial and from there they may again go on to the Main Variety Trial.

Differences in 1954 were not significant although yields were good, the best strain giving over 1200 lbs. of kernels per acre. In 1956 the design of the experiment is to be altered from Randomized Blocks to a Balanced Incomplete Blocks design in the hope of increased accuracy and also to bring into line with the Main and Second Variety Trials.

Early Maturing Variety Trial.—This trial has been un-modified for three years. Dixie Runner and Phillipine White which head the list this year are not early maturing varieties taking approximately two weeks longer to mature than the other varieties in this trial. Of these two, Dixie Runner has been very consistent and of the early varieties

279-6 has been also consistently in the lower half. The complete summary for the three years is seen in Table 37.

TABLE 37.—SAMARU EARLY MATURING VARIETIES TRIAL

<i>Varieties</i>	<i>Yield lb. kernels/acre</i>		
	*** 1953	* 1954	*** 1955
Dixie Runner	945 (4)	441 (1)	1,245 (1)
Phillipine white	770 (8)	263 (9)	1,190 (2)
279-6	1,130 (1)	389 (3)	1,059 (3)
Valencia	781 (6)	338 (6)	862 (4)
Toro	487 (9)	330 (7)	857 (5)
Natal Common	876 (5)	356 (5)	772 (6)
Kono	775 (7)	308 (8)	751 (7)
Spanish 205	949 (3)	415 (2)	741 (8)
278-4	966 (2)	387 (4)	667 (9)
S.E.	±75	±34	±87

Figures in brackets in columns 3-5 indicate relative positions.

B.—GUSAU TRIAL

A variety trial here compared what is generally considered the best variety for the area namely Castle Cary with six of the "L" selections. Yields were remarkable in that even the poorest variety gave over 1,100 lbs. of kernels and over 1,700 lbs. of haulms per acre. A summary of the result which was not significant is given in Table 38.

TABLE 38.—GUSAU VARIETY TRIAL

lb. per acre

<i>Treatments</i>	<i>Kernels N.S.</i>	<i>Haulms N.S.</i>
L 250	1,251	1,759
L 245	1,220	1,775
L 234	1,188	1,759
L 266	1,156	1,844
L 258	1,154	1,711
L 235	1,148	1,614
Castle Cary	1,135	1,727
S.E.	±41	±74

C.—KAFINSOLI TRIAL

A variety trial at Kafinsoli which also included some of the "L" strains unfortunately had to be cancelled due to the late arrival of some of the seed after being mislaid in the post.

D.—ZONKWA TRIALS

Two variety trials were again laid down at Zonkwa, one containing nine mostly early maturing varieties and the other nine late maturing ones. Yields were poor and unfortunately due to a mistake in planting it was not possible to analyse the trial containing the late maturing strains. A summary of the yields from the mainly early varieties can be seen in Table 39. Dixie Runner and Mache Atsugune were significantly ** better than Valencia, while Phillipine White was significantly * better than Valencia and Natal Common. It is of interest that these three varieties are late maturing.

TABLE 39.—ZONKWA EARLY MATURING VARIETY TRIAL

<i>Varieties</i>							<i>Yield in lbs. kernel per acre **</i>
Dixie Runner	...	...	...	...	...	...	335
Mache Atsugune	...	...	...	...	...	...	334
Philippine White	...	...	...	...	...	...	294
Spanish 205	...	...	...	...	...	...	253
279-6	...	...	...	...	...	...	247
Kono	...	...	...	...	...	...	247
278-4	...	...	...	...	...	...	233
Natal Common	...	...	...	...	...	...	222
Valencia	...	...	...	...	...	...	209
S.E.	...	...	...	...	...	...	±23

E.—KANO TRIALS

Three groundnut variety trials were carried out in Kano Province in 1955. Two of these were on the main farm and were the same or slightly modified repeats of those laid down the year before. A new trial was however sited at Gumel in the Northern part of the Province in which two good local varieties were tried against Kano 50 and two Samaru selections.

The result of this trial and the New Selections Trial held at the Kano farm are seen in Tables 40 and 41 respectively.

TABLE 40.—NEW SELECTIONS TRIAL, KANO
lb per Acre

<i>Treatments</i>	1955		1954
	<i>Kernels N.S.</i>	<i>Haulms N.S.</i>	<i>Kernels N.S.</i>
L 60	1,027	1,367	726 (6)
L 260	1,001	1,482	742 (7)
Samaru 38	996	1,353	583 (9)
Kano 50	992	1,427	807 (3)
L 235	982	1,460	883 (1)
L 245	959	1,502	838 (2)
L 234	897	1,340	701 (8)
Kano 38	890	1,382	791 (4)
S.E.	±53	±69	±61

Figures in brackets in the last column indicate relative positions in 1954.

The table of yields for the trial at Gumel shows that both MK 383 and MK 374 were significantly *** better than both the local varieties *Hakemin Dan Zomo* and Local Spreading, while Kano 50 was significantly ** better than them both also.

TABLE 41.—GUMEL VARIETY TRIAL
lb. per Acre Undecorticated

<i>Varieties</i>	<i>Yield ***</i>
MK 383	743
MK 374	740
Kano 50	690
Local Spreading	469
<i>Hakemin Dan Zomo</i>	374
S.E.	±48
5 per cent Sig. Diff.	141
1 per cent Sig. Diff.	192
0.1 per cent Sig. Diff.	256

F. MAIDUGURI TRIAL

A trial comparing five varieties of groundnut grown on the ridge and on the flat was initiated in 1955. The varieties included both Maiduguri and Daura local spreading together with ML 378, Kano 50 and Samaru 28,

Yields were, considering the year, about average. A non-significant result was obtained and the trial is to be repeated in the coming year.

(g) *Yandev Trial*.—In the variety trial at Yandev in 1955, the two varieties 279-6 and 278-4 were substituted for Yandev local and Dixie Runner. However, due to wide variations in the final stand count and to the very low yields resulting from rosette attack, the trial was not statistically analysed.

3. GERMINATION AND SEED SIZE OBSERVATION

It had been noticed that despite the fact that ample seed in shell was set aside for an experiment the number of kernels obtained after decortication was frequently reported to be insufficient to plant and supply all the replications. Further investigation showed that the shelling percentage of under fifty per cent was due to many kernels being discarded because they were small, wrinkled and immature and because they were of poor colour.

In order to enquire into this further, a typical example of Samaru 38 nuts were shelled and the kernels divided by size and colour into ten classes. Twenty-five seeds of each class were tested for germination on moist filter paper under petri dishes in the laboratory and the results which can be seen in Table 42 show that only the very smallest gave an unsatisfactory germination figure.

TABLE 42.—GERMINATION AND SEED SIZE

Date	25/7	26/7	27/7	28/7	29/7	% Germinated	
	Number Germinated	Number Germinated	Number Germinated	Number Germinated	Number Germinated		
A	1	2	1	—	—	16	Smallest
B	20	1	—	—	—	84	
C	18	2	1	—	—	84	
D	25	—	—	—	—	100	
E	15	9	1	—	—	100	
F	19	4	1	—	—	96	Medium
G	22	3	—	—	—	100	
H	24	1	—	—	—	100	
I	11	5	2	4	1	92	Largest
J	5	8	5	4	1	92	

Further tests on establishment in the field gave a similar result and it has been decided to take the matter one stage further in 1956 with a full scale replicated field trial.

4. DORMANCY OBSERVATIONS

The observation started in 1954 was repeated in a modified and enlarged form in 1955. Twenty-eight of the more widely used varieties were again tested. One row of each was harvested at intervals of two weeks, four weeks and six weeks after maturity. These rows had been watered every two days up to the time they were lifted. After harvesting the plants, the nuts on them were examined for sprouting.

One row of each variety had previously been harvested at maturity and the nuts from this were tested for germination at weekly intervals in the laboratory.

It would appear from the results (*see* Tables 43 and 44) that the factor for dormancy is a characteristic of the long and semi-long season varieties and lacking in the short season types.

TABLE 43.—DORMANCY OBSERVATIONS RESULTS OF FIELD TEST

Weeks after maturity							2	4	6
Variety									
Spanish 205	...	...	...	...	...	...	3.55	4.87	12.14
Natal Common	...	...	...	...	...	...	4.83	30.49	9.32
Valencia	...	...	...	...	...	...	22.09	15.38	33.33
279-6	...	...	...	...	...	...	0.96	6.61	4.21
All semi-late and late varieties	...	...	...	...	...	...	0.00	0.00	0.00

Figures represent percentage of nuts sprouted

TABLE 44.—DORMANCY OBSERVATION
*Germination Test at Weekly Intervals after Harvest
based on Samples of 25 good Kernels*

Varieties						Percentage Germination at					
Weeks						1	2	3	4	5	6
<i>Earlies</i>											
Spanish 205	..	..	..	..	..	?	12	4	24	4	8
Valencia	..	..	..	..	..	?	12	32	12	12	12
Toro	..	..	..	..	..	?	4	44	32	8	12
Kano	..	..	..	..	..	?	24	32	28	0	12
279-6	..	..	..	..	..	?	20	24	20	4	4
Average Earlies	..	..	..	..	..	?*	14.5	27.2	23.2	5.6	9.6
<i>Semi Lates</i>											
Philippine White	..	..	..	..	..	0	0	0	4	4	16
Dixie Runner	..	..	..	..	..	0	0	0	0	0	0
Average Semi lates	..	..	..	..	..	0	0	0	2.0	2.0	8.0
<i>Lates</i>											
MJ 374	..	..	..	..	..	0	0	0	0	4	0
Castle Cary	..	..	..	..	..	0	0	0	0	0	4
Kontagora Local	..	..	..	..	..	0	0	0	0	16	0
MK 383	..	..	..	..	..	0	0	0	0	8	12
Samaru 38	..	..	..	..	..	0	0	4	0	4	4
Kano 50	..	..	..	..	..	0	0	0	0	8	4
MJ 371	..	..	..	..	..	0	0	0	0	4	36
Kano 38	..	..	..	..	..	0	0	0	0	0	0
ML 3710	..	..	..	..	..	0	0	0	0	8	0
Average Lates	..	..	..	..	..	0	0	0.4	0	5.8	6.7

*In the case of earlies the first test ran for two weeks and separate figures for one week were not recorded,

5. GENETICAL OBSERVATIONS

All treatments for the 1954 layout were progeny rowed in 1955. Six varieties differing from each other in testa colour and/or habit of growth were replicated six times and laid out in such a way that each variety was practically surrounded by others of different type with the object of observing the amount of outcrossing, if any, that occurs in the field.

Observations on the growth habit of the progeny rows revealed none of the offtypes that would have indicated outcrossing. After shelling, however, kernels were found that differed slightly in colour from that of their original parent. This will be examined further in 1956 at Kano experimental farm as the large amount of land now required to accommodate this work cannot be spared at Samaru.

6. SEED DISINFECTION TRIAL AT SAMARU

This trial has not given a significant result either in germination or in yield for three years, and it has been decided to discontinue it. Germination this year was good in all treatments, those including Agrocide and Killoptera being slightly better.

Table 45 shows the yield in lb. of kernels and the germination figures.

TABLE 45.—SEED DISINFECTION TRIAL, SAMARU

<i>Treatments</i>						<i>Yields lb/ kernel/acre N.S.</i>	<i>Per cent Germination</i>
Control	...	...	...	...	...	1,274	92
Killoptera	...	...	...	...	...	1,246	96
Carbon disulphide	...	...	...	...	...	1,222	91
Gammexane	...	...	...	...	...	1,206	86
Napthalene	...	...	...	...	...	1,188	94
Agrocide	...	...	...	...	...	1,173	98
Carbon tetrachloride	...	...	...	...	...	1,143	92
S.E.	...	...	...	...	...	±50	—

C. MILLET (PENNISETUM TYPHOIDEUM) (D.L.C.)

1. BREEDING

(a) *Introductions*.—During the dry season samples of gero, maiwa and dauro were sent in from outstations. These will be grown at Samaru in

1956. In addition introductions of gero were received from French Niger Territory and the Belgian Congo. The French introductions performed well in the Farm Garden at Daura. The introduction from the Belgian Congo will be tested in 1956 for bird resistance.

(b) *Selection Work*.—Selfing of early maturing, high yielding types was continued with a view to producing inbred lines. These will be tested for combining ability. The aim will be to produce an elite synthetic outbreeding population.

2. TRIALS AND OBSERVATIONS

Millet early maturing yield trial, Samaru.—Based on the results obtained in 1953 and 1954, the best nineteen selections were chosen for inclusion in a yield trial. Unselected material was used as a standard. Yields were appreciably lower than in 1954, but the selections maintained their superiority over unselected material. The trial was planted on 29-4-55, and most selections were harvested 10-8-55. Four selections reached maturity around 12-7-55, but the unselected material was not harvested until 19-8-55. Results are shown in Table 46.

TABLE 46.—MILLET EARLY MATURING YIELD TRIAL, SAMARU

Yield in lb. threshed grain/per acre

<i>Selection</i>				<i>Yield</i>	<i>Selection</i>				<i>Yield</i>
318	...	...	...	557	216	...	...	...	399
215	...	...	...	526	217	...	...	...	390
305	...	...	...	522	196	...	...	...	883
204	...	...	...	479	311	...	...	...	376
106	...	...	...	474	36	...	...	...	366
56	...	...	...	457	234	...	...	...	356
195	...	...	...	454	46	...	...	...	345
261	...	...	...	426	39	...	...	...	333
21	...	...	...	407	Unselected	...	...	...	149
48	...	...	...	408	Unselected	...	...	...	115
338	...	...	...	400					
S.E.	...	...	...	±56	S.E.	...	...	...	±56

Millet early Selections hybrids trial, Samaru.—This trial was a repeat of the hybrids trial in 1954. As in the last trial, yields were lower in 1955. Apart from the cross 182x278, there was not a constant trend in superiority. Results are shown in Table 47.

TABLE 47.—MILLET EARLY SELECTIONS HYBRIDS TRIAL, SAMARU
lb. Threshed grain per acre

<i>Hybrid</i>	1954	1955*	<i>Mean</i>
182x278	1663	716	1189
78x202	1285	699	992
243x158	1362	670	1016
156x263	1304	644	974
93x223	1450	626	1038
61x178	1408	625	1017
47x86	1457	619	1038
117x200	1319	612	965
99x236	1399	601	1000
117x277	1406	587	997
83x207	1423	584	1001
70x19	1079	580	829
102x130	1408	551	979
28x114	1452	546	999
240x71	1331	505	918
246x281	1329	479	904
S.E.	±162	±56	—

D.—MAIZE (ZEA MAYS)

1. BREEDING

(a) *Introductions*.—There were no direct introductions from abroad but hybrids, varieties and lines were received from the West African Maize Research Unit, Ibadan. These were grown in variety trials and observation plots. It is hoped that by screening this material, the types of maize best suited to the Northern Guinea Zone will be obtained.

(b) *Selection Work*.—Four lines of Mexico I (S3) and two lines of Mexico 5 (S3) were received from Ibadan. The best plants in each line were selfed and the seed bulked within the line.

(c) *Hybridization*.—The first cross material of a standard U.S. hybrid with the variety Mexico I has been selfed. The programme is aimed at producing a synthetic from the more promising crosses.

The parent seed of the hybrid, Asgrow Wisconsin 464, was grown at Samaru. It should have been crossed with Mexico I but the flowering periods did not coincide.

2. TRIALS AND OBSERVATIONS

(i) *Maize Hybrids Trial, Samaru*.—High yields were obtained (Table 48) from nine hybrids sent from Ibadan.

TABLE 48.—MAIZE HYBRIDS TRIAL, SAMARU

lb. dry grain per acre

<i>Hybrid</i>					<i>Yield</i> <i>N.S.</i>
987/55 Mex. 16 x Br. 157 Trinidad	...	...	...	...	2339
976/55 (Cuba Amarillo x Mex 16)x(Sicaragua x Cuba Amarillo)	...	...	...	...	2074
1002/55 Mexico 5 x Dom. Rep. 63	...	...	...	...	2064
996/55 Mexico 16 x Mexico 4	...	...	...	...	2010
993/55 Mexico 1 x Dom. Rep. 63	...	...	...	...	1859
1004/55 Mexico 1 x Mexico 4	...	...	...	...	1842
998/55 Mexico M x Mexico 1	...	...	...	...	1838
977/55 Sicaragua x La Creole	...	...	...	...	1674
980/55 Sicaragua x Cuba Amarillo	...	...	...	...	1173
S.E.	...	...	...	...	±236

(ii) *Maize Variety Trial, Samaru.*—The lines for this trial were multiplied during the dry season and the trial was planted on 18-7-55. Selfed seed was used and therefore the results are of limited application. (See Table 49).

TABLE 49.—MAIZE VARIETY TRIAL, SAMARU

(lb. dry grain per acre)

<i>Variety</i>					<i>Yield</i> <i>N.S.</i>
875 British 158 Trinidad	...	...	...	...	1469
961 Bounty Early Yellow Mex 1	...	...	...	...	1334
967 Cuba Amerillo x Mex 16	...	...	...	...	1301
1,051 Sicaragua x Mex 16	...	...	...	...	1268
881 British 147-11	...	...	...	...	1223
1,080 Mexico 5	...	...	...	...	1112
956 Tall Western Dent x Mex 16	...	...	...	...	1069
643 Sicaragua	...	...	...	...	1026
809 British 149 Trinidad	...	...	...	...	867
1,064 Button Corn	...	...	...	...	817
955 White Bounty x Mex 13	...	...	...	...	787
960 La Creole x Mex 16	...	...	...	...	784
1,063 Mexico 1	...	...	...	...	782
781 British 159 Trinidad	...	...	...	...	697
S.E.	...	...	...	...	±237

(iii) *Observations.*—15 hybrids were grown in observation plots and records kept of their performance. The calculated yield of grain ranged from 68 to 2,020 lb. per acre.

((B) Ilorin) results sent direct to W.A.M.R.U. and copies

((C) Mokwa) have not yet been sent to Regional Research Station.

3. MAIZE SURVEY

The maize survey of West African Territories being carried out by the West African Maize Research Unit continued. Replies to questionnaires and samples of seed were sent direct to Ibadan from all provinces in the Northern Region.

E. GUINEACORN (SORGHUM SPP.)

1. *Breeding*

(a) *Introductions.*—There were many introductions during the year including 541 from the Sudan, 25 from French Niger Territory and 15 from the Gold Coast.

The introductions from the Sudan were mainly short stemmed types which will be grown in the Uniform Nursery and kept as a potential source of breeding material. One U.S. variety and one from South Africa, which may have some value in breeding for resistance to Striga, were included in this consignment.

The 25 varieties from French Niger Territory are selections made at Maradi. Some of the higher yielding selections will be put into a yield trial with Nigerian local varieties as standards. It may be possible to utilize these selections without further improvement.

The Gold Coast selections were all of the Nunaba type. The main reason for their introduction is to test their resistance to the Sorghum midge under Nigerian conditions.

A reputedly bird resistant guineacorn was received from the Belgian Congo and will be grown in 1956.

(b) *Selection Work.*—Bird resistance; selection for the bitter principle, present in the unripened grain, was continued. Although promising reports on the same material have been received from Maiduguri, it was only with difficulty that sufficient seed was saved from the ravages of the birds at Samaru.

Pale grained Kaura: a pale grained selection was grown at Samaru and the best plants saved for further selection.

(c) *Hybridization.*—Dr Webster's Programme. Progress has not been satisfactory with this programme which started in 1951. One of the main difficulties has been the synchronising of the flowering dates for the local

varieties and the hybrids. This has meant that the backcross technique has not been used. This year a few backcrosses were made, but in future the recurrent parents, (local varieties) will be sown throughout the season and hybrids will be cut back to delay flowering, if necessary.

In the crosses with Farafara the aim was to transfer the yield potential and short stem from the U.S. varieties to Farafara. This has not been achieved. As a general description the crosses might be termed U.S. varieties with a taller habit and a slightly longer growing period. The panicle and grain characters resemble the U.S. parents.

The crosses with Kaura have resulted in lines which have a white seed coat and yellow endosperm. These might be of value. The Kaura x Sorgho crosses have not been successful and it would appear that the sweet and juicy characters have been lost.

(d) *Multiplication*.—The multiplication of common local varieties was continued. A new programme for Short Kaura was started.

The varieties are not being multiplied for distribution but mainly for use in experiments.

2. TRIALS AND OBSERVATIONS

(a) *Variety Trials*.—The 1954 variety trials were repeated in 1955 with a few modifications. The aim is to find varieties which are suitable for large areas. A programme can then be drawn up for the improvement of these varieties. It is difficult even to attempt an improvement in every local variety beyond selection work at the outstations. Results of the four trials are shown in Tables 50 and 51.

TABLE 50.—MIDDLE BELT VARIETY TRIALS

lb. dry grain per acre

Variety	Origin	Station								Mean
		Yandev		Zonkwa		Kontagora		Samaru		
		1954	1955	1954	1955	1954	1955	1954	1955	
		***	**	N.S.	***	***	***	***	Not analysed	
Farafara ...	Samaru ...	1,089	708	306	515	509	722	763	72	585
Farafara ...	Kontagora ...	618	634	351	332	726	647	676	60	505
Akuki ...	Yandev ...	466	306	359	357	1,027	879	77	322	474
Janare ...	Zonkwa ...	705	328	359	413	695	871	248	125	468
Tall Kaura	Samaru ...	510	668	516	599	555	432	513	34	478
Agyan ...	Zonkwa ...	313	383	238	446	475	619	123	107	338
S.E. ...		± 32	± 61	± 68	± 27	± 60	± 62	± 72		

TABLE 51.—NORTHERN VARIETY TRIALS
lb. dry grain per acre

Variety	Origin	Station								Mean
		Gusau		Maiduguri		Kano		Samaru		
		1954	1955	1954	1955	1954	1955	1954	1955	
		***	***	Not analysed	***	Not analysed		Not analysed	Not analysed	
Shambul	Maiduguri	258	128	1,781	2,203	355	433	15	352	691
Farar Kaura	Daura ...	292	407	1,319	1,489	573	496	35	19	579
Short Kaura	Samaru	95	—	15	—	36	—	7	—	38
Yar Gunki	Kano ...	494	1,415	32	—	367	493	21	29	404
F.C.										
Standard	Gusau ...	436	1,212	52	—	367	347	31	22	353
Farafara loose panicle	Gusau ...	408	1,139	56	—	331	392	47	31	348
Buturi Huta	Daura ...	—	210	—	1,034	—	396	—	—	528
Gwoza local	Maiduguri	—	—	—	2,421	—	—	—	—	—
Jan Jare	Sokoto ...	—	—	—	1,557	—	—	—	—	—
Jaddawa	Sokoto ...	—	—	—	264	—	—	—	—	—
S.E.		±33	±49	—	±85	—	±57	—	—	—

(b) *Variety trials interplanted according to local practice.*—

Yandev—Interplanted through early millet.

Ilorin—Interplanted through early maize.

TABLE 52.—INTERPLANTED VARIETY YIELD TRIALS
Summary of yields in lb. per acre

Variety						Station	
						Ilorin ***	Yandev ***
Farafara ...	...	...	...	...	Samaru	657	754
Farafara ...	...	...	...	...	Kontagora	708	640
Akuki ...	...	...	...	...	Yandev	155	452
Janare ...	...	...	...	...	Zonkwa	640	580
Tall Kaura	...	...	...	...	Samaru	504	751
Agyan ...	...	...	...	...	Zonkwa	—	483
Local ...	...	...	...	...	Ilorin	722	—
S.E. ...	...	...	...	...	—	±29	±66

(c) *Local Varieties and U.S. Varieties.*

TABLE 53.—U.S. AND LOCAL VARIETY TRIAL, DAURA

lb. dry grain per acre

<i>Variety</i>							<i>Origin</i>	<i>Yield</i> ***
Shambul	...	...	...	...	...	...	Maiduguri	715
Ladore	...	...	...	...	...	...	U.S.A.	794
Farar Kaura	...	...	...	...	...	...	Daura	400

Ladore has consistently yielded well in trials in Northern Nigeria. Shambul has also yielded well at stations other than Maiduguri. The question still remains whether either of these varieties will replace the local Farar Kaura. Ladore, with a short stem is not likely to be acceptable in this area where the stems are used for building purposes. If Shambul continues to yield higher than Farar Kaura, small samples should be tested for palatability, etc., among local farmers.

TABLE 54.—LOCAL VARIETIES TRIALS, KANO

lb. dry grain per acre

<i>Variety</i>			<i>Yield</i>		<i>Mean</i>
<i>Origin</i>			1954	1955	
			*	*	
Tall Kaura	...	...	2,177	1,329	1,753
Yar Gunki	...	...	2,208	1,029	1,618
Kaura Broomhead	...	...	2,177	1,154	1,665
Farafara Compact	...	...	1,983	712	1,347
S.E.			±160	±113	—

The results of 2 years trials at Kano (Table 54 have been consistent). There is little to choose between the first three varieties. Compared with other trials the yields in both years were above average.

(d) *Observations.*—Time of planting of U.S. guineacorn—LADORE, at Yandev.

This observation trial was repeated. The aim is to find out whether or not a short season guineacorn can be planted with the early rains and mature during the short dry season in July or August. Unfortunately the range of planting dates did not start early enough (See Table 55).

TABLE 55.—LADORE PLANTING SEQUENCE, YANDEV

lb. dry grain per acre

<i>Planting date</i>		<i>Yield</i>	<i>Planting date</i>		<i>Yield</i>
1-7-55	...	144	5-8-55	...	40
8-7-55	...	137	12 8-55	...	34
15-7-55	...	97	19-8-55	...	33
22-7-55	...	96	26-8-55	...	32
29-7-55	...	65	2-9-55	...	23

Planting sequence trials of Hegari and Ladore at Maiduguri:—

These were a complete failure due to the destruction of the plots by grazing cattle.

3. UNIFORM NURSERY

278 varieties were grown in single rows. These represented approximately half the total collection at planting time. The varieties are planted every other year. Since then, with the introduction of varieties from the Sudan and French Niger, the collection has increased to almost 1,100. This is an important part of the guineacorn improvement programme, but with a shortage of assistants it is difficult to take adequate observations.

4. LABORATORY WORK

During the dry season 1955-56 work began on analyses of yield components in Short Kaura and Farafara. These results will give an indication of variability within a variety and although the work is at an early stage, it has already suggested possible selection criteria. These criteria will be applied in conjunction with habit characters for the selection techniques for 1956.

As a necessary adjunct to breeding work on guineacorn a trial to determine the percentage outcrossing in Nigerian varieties will be laid down. Small preliminary tests were made in the laboratory in an attempt to find a suitable character which would obviate the necessity to grow on the F 1 in the field. The results have not been encouraging and it will almost certainly be necessary to grow on the F 1 seedlings in the field.

F.—SOYA BEANS (GLYCINE MAX) (A.R.M.)

As stated in last year's report, Soya beans are increasing in importance in parts of the Middle Belt. In 1955-56 the export tonnage of soya beans in Niger Province exceeded that of groundnuts for the first time. The total tonnage exported from Nigeria between January and December 1955 was 8,975 tons, worth £340,901.

The focal point of expansion is in Niger Province and it is here that, we plan to conduct extensive trials.

In 1955 variety yield trials were conducted at Samaru and Kontagora while observation plots of soya varieties were grown at Mokwa, Kontagora Bida, Ilorin, Yandev, Shendam, Maiduguri and Samaru.

Soya Bean Variety Yield Trial, Samaru.—This experiment is one of a series begun in 1952 to determine the performance of our better-yielding Soya bean varieties at Samaru. Table 56 presents the yields obtained in 1955, together with those of other years.

Although there were no significant differences in yields in 1955, the trend established by Bilomi No. 3 has continued and it is again the top yielding variety, but Malayan and Miscellaneous 94 are very close to it.

A modified trial with 15 varieties will be planted in 1956.

TABLE 56.—SOYA BEAN VARIETY TRIAL, SAMARU

Yields in lb. per acre, threshed seed

Variety	1949	1950	1951	1952	1953	1954	1955	Average
	***	**	***	N.S.		*	N.S.	
Bilomi No. 3 ...	—	—	1,184	1,174	—	746	834	1,035
Miscellaneous 94 ...	—	—	1,088	1,154	—	819	813	968
Avoyelles ...	1,102	823	—	—	—	—	—	963
Benares ...	1,079	963	846	986	—	824	830	921
Malayan ...	1,032	—	—	1,038	—	601	674	836
Bilomi No. 1 ...	—	—	1,021	1,048	—	508	732	827
Yellow Bermelly ...	—	—	798	1,159	—	813	518	822
28 E B ...	—	—	—	980	—	706	708	798
Black Matted Java ...	—	—	983	974	—	709	515	796
Arcadian ...	935	654	—	—	—	—	—	794
Mamloxi ...	719	612	—	—	—	—	—	666
S.E. ...	±33	±65	±50	±264	—	±80	±100	—

Soya Bean Variety Trial, Kontagora.—This trial is the second of a series begun in 1954 to find the best yielding soya bean variety for Kontagora, having the Kontagora Land Settlement Scheme in particular in mind. Yield figures for 1954 and 1955 are shown in Table 57.

TABLE 57.—SOYA BEAN VARIETY TRIALS, KONTAGORA

lb. threshed beans per acre

Variety	1954	1955	Average
	***	***	
Yellow Bermelly ...	752	723	737
Malayan ...	541	866	703
Miscellaneous ...	634	702	668
28 E.B. ...	606	648	627
Black matted Java ...	438	808	623
Dixie ...	669	557	613
Bilomi No. 3 ...	406	792	599
Benares ...	544	481	512
Bilomi No. 1 ...	42	700	371
S.E. ...	±52	±60	

(In 1954 the yield of Bilomi No. 1 was too low to be included in the analysis).

The variety Yellow Bermelly which did well in 1954 and which was consequently recommended for multiplication was again among the top yielders in 1955. Malayan which is also a variety recommended in the Middle Belt was top yielder in 1955.

The trial is being repeated in 1956 to confirm our findings.

G.—SUNFLOWER (*HELIANTHUS ANNUS*)

The work on Sunflower has been reduced to a minimum as the crop is now of minor importance in most parts of the Northern Region. In future it will be recommended only for silage-making and for this purpose the tall unimproved grey-seeded variety is quite suitable. In 1955 only one yield trial was conducted in the North and that was at Samaru.

This trial (*see* Table 58) was the last of a series of four in which four improved varieties were tested against local Grey-seeded for seed (not silage) yield.

TABLE 58.—SUNFLOWER VARIETY YIELD TRIAL

lb. dry threshed seed per acre

<i>Variety</i>	1950	1951	1952	1955	<i>Average</i>
	***	***	**	**	
Grey Seeded	983	1147	1033	829	998
Saturn	1049	846	909	900	928
Hungarian	898	406	594	564	616
Advanced Hybrid ...	—	330	506	614	483
Sunrise	513	165	378	485	385
S.E.	—	±24	±23	±84	—

Grey-seeded although not actual top yielder this year has maintained a high position throughout the series of trials. Of the imported varieties, Saturn has consistently given better yields than Hungarian, Advanced Hybrid and Sunrise and on the basis of these results can be recommended in the Samaru area as a high-yielding, large headed oil-seed type.

H.—SUGAR CANE (*SACCHARUM OFFICINALE*)

At Samaru, priority is being given to multiplication and to the testing of all of our varieties against the Red Rot disease.

Multiplication of cane varieties has continued both at Samaru and at Maigana. We are now in a position to recommend several resistant strains for multiplication throughout the Region, but due to the fact that all resistant strains are of the hard type, there is not much demand for them among the

sugar-cane farmers. Farmers find it more profitable to grow the susceptible, soft-chewing canes as these fetch one penny each on the market. It is clear that considerable extension propaganda will have to be used to convince the farmer that our canes are a better risk in that they are resistant to Red Rot, give higher yields of sugar per acre, can be satisfactorily crushed with the common horse-operated crusher and can be successfully ratooned.

During the past year, a report has been prepared on the sugar-cane, crushers and evaporating tanks in use at Maigana. Plans for an improved type of bagasse-burning furnace have been obtained from India and construction is in hand.

In 1955 the series of Sugar Cane variety trials at Maigana was continued. The 1954 experiment was ratooned and a new planting took place.

Sugar Cane Variety Trial, Maigana; First Ratoon Crop.—The six varieties planted in 1954 were ratooned and produced a good crop of cane. As expected, the local cane did not perform at all well. Table 59 shows the yields obtained in both years of this trial.

TABLE 59.—YIELDS OF CANE AND CANE SUGAR VARIETY TRIAL, 1954-55

Variety	Yield in lb. per acre					
	Cane yields		Sugar yields		Percentage of Sucrose in extracted juice	
	1954	1955	1954	1955	1954	1955
	N.S.	**	N.S.	**		
CO 331	26,100	23,440	675	3,099	2.59	13.21
"No. 8"	21,891	22,452	443	2,829	2.02	12.59
"No. 3"	21,451	20,842	281	2,528	1.31	12.12
"No. 5"	25,726	20,242	509	2,515	1.98	12.42
CO 213	22,318	16,810	676	2,432	3.03	14.46
Uba	17,635	17,124	376	2,123	2.13	12.39
Local	11,306	2,181	241	266	2.13	12.19
S.E.		±3,289		±433		

Results are most encouraging. As expected the yields of cane from the ratooned trial are greatly superior to those of the first year planting. The percentage of sugar in the cane has increased about five times while the actual yields of cane per acre are approximately the same.

In 1955 CO 331 gave the best performance while local, which is susceptible to Red Rot was very poor.

Sugar Cane Variety Trial, Maigana; (New Planting).—This trial is a repetition of last years' and is the last to contain some of the fodder canes,

These are being replaced with the new Red Rot resistant varieties, as they become available in sufficient quantities. Table 60 presents the results obtained in 1952 and 1955. 1954 yields are included again for comparative purposes, although they have already been presented in Table 59.

In 1955 variety CO 213 gave the best performance while the local, which suffered from Red Rot attack gave very poor results.

The figures for percentage of sugar in Table 60 represent the quantity of sucrose in the whole cane. The actual percentage of sucrose in the extracted juice of each variety is shown in Table 61.

TABLE 60.—SUGAR CANE VARIETY TRIALS MAIGANA
Yields in lb. per acre

Variety	Cane Yields			Sugar Yields			% Sucrose in whole cane			Average yield of Sugar
	1952	1954	1955	1952	1954	1955	1952	1954	1955	
	N.S.	N.S.	*	*	N.S.	*				
Uba ...	20,025	17,635	8,708	1,280	376	268	6.4	2.13	3.08	675
CO 213	14,520	22,318	13,470	784	676	489	5.4	3.03	3.63	650
"No. 4"	14,762	—	—	607	—	—	4.1	—	—	(607)
CO 331	21,280	26,100	9,599	854	675	279	3.5	2.59	2.90	603
"No. 8"	13,269	21,891	13,190	713	443	407	5.4	2.02	3.09	521
"No. 5"	12,523	25,726	7,983	462	509	231	3.7	1.98	2.89	401
"No. 3"	—	21,451	11,357	—	281	253	—	1.31	2.23	267
Local	—	11,306	3,032	—	241	106	—	2.13	3.49	174
S.E. ...	—	—	± 2,262	± 142	± 7	± 73	—	—	—	—

The yields of Gold Dollar and Harrison Special were significantly higher than those of Little Crittenden, Improved One Sucker and Lizard Tail Orinoco. This is encouraging as these two varieties also produced a better quality of cured leaf.

J.—BENNISEED (SESAMUM INDICUM)

The selection programme at Yandev continued as in previous years. Some of the heavy yielding strains issued to farmers by A.O., Yandev have performed very well, but the cultivators have complained that our pure strains have a uniform period of maturity and whereas they could previously harvest at leisure over a ten-day to two-week period, they now have to harvest everything within a few days. This causes them to lose some of the seeds but their total harvest is still greater than it was before.

Early Selections, Families Vs. Strains Trial.—The 1955 results confirm our findings regarding early maturity and we are confident that our strains are capable of maturing at an earlier date than the local unselected seed.

The findings on actual yields over a period of four years are not so clear. There appears to be a marked difference in the relative performance of the various families from year to year. (Table 63).

TABLE 63.—BENNISEED FAMILIES VS. STRAINS TRIAL, YANDEV
lb. threshed seed per acre

<i>Families</i>	1952	1953	1954	1955	<i>Average</i>
	**	**	—	**	
D	299 (4)	80 (5)	259 (1)	286 (4)	241
J	311 (3)	70 (9)	233 (4)	299 (3)	229
H	347 (2)	74 (6)	213 (5)	275 (5)	227
A	374 (1)	125 (1)	194 (6)	197 (10)	223
E	273 (7)	82 (4)	240 (3)	259 (7)	213
Unselected (U)	293 (5)	94 (3)	179 (7)	274 (6)	210
C	265 (8)	71 (8)	194 (6)	308 (2)	207
F	259 (9)	73 (7)	152 (9)	315 (1)	200
G	236 (10)	55 (10)	246 (2)	224 (9)	190
B	280 (6)	117 (2)	115 (8)	247 (8)	190
S.E.				±21	

(Figures in brackets indicate position in each trial).

Benniseed Strains Trial, Yandev.—This is the fourth trial in a series undertaken to determine whether some of the selections are capable of out-yielding Yandev Unselected seed over a period of years.

Table 64 compares this year's results with those obtained previously.

TABLE 64.—BENNISEED STRAINS TRIAL, YANDEV
lb. threshed seed per acre

<i>Strain</i>	1952	1953	1954	1955	<i>Average</i>
	<i>N.S.</i>	<i>N.S.</i>	<i>N.S.</i>	<i>N.S.</i>	
064	428 (3)	275 (1)	417 (1)	240 (4)	340
0361	501 (1)	230 (3)	361 (2)	264 (2)	339
055	453 (2)	234 (2)	338 (3)	251 (3)	319
Unselected	—	230 (3)	326 (4)	299 (1)	285
S.E.	—	—	±28	±35	—

Although results have been consistently non-significant, the trend is in favour of the selected material except for the 1955 figure. The trial is being repeated in this form in 1956, but will then be altered and a greater number of selections will be tested.

K.—SAFFLOWER (*CARTHAMUS TINCTORIUS*)

Samples of Safflower were introduced to Samaru several years ago and some difficulty was experienced in growing this crop. Seeds were sent to several stations where they all failed.

Safflower is a plant which thrives in dry climates and it was therefore decided to conduct an observational trial on time of planting. Four planting dates were used. The results are shown in Table 65.

TABLE 65.—SAFFLOWER TIME OF PLANTING OBSERVATION, SAMARU
lb. threshed Seed per acre

<i>Variety</i>	<i>Planting Dates</i>			
	22-7-55	29-7-55	5-10-55	12-10-55
Indiana	38	11	38	594
No. 8	6	51	44	233
No. 3	25	6	43	215
No. 852	50	13	25	34

Late planting is beneficial to seed production; this is in spite of the fact that because of poor seed the per cent stand of the late planting was much lower.

It was also observed that the plants growing on higher ground gave better yields.

In 1956 a planting-sequence trial will be undertaken.

L.—RICE (*ORYZA SATIVA*)

The Botanist Section is responsible for the maintenance of purity in the G. 79 Rice multiplication scheme at Maigana. Tests are carried out at Samaru to determine the purity of G. 79 at all stations. The results obtained this year are shown in Table 66.

The Maigana seed has improved greatly and for the first time contained no red off-types in any of the stages. The off-types in shape can be expected as G. 79 grown in Northern Nigeria is not a genetically pure variety. There is a range within the variety of seed shapes varying from a longish seed to one that is rather squat. There is also some variation in plant characters. The Federal Rice Research Station at Bida is developing pure lines G. 79 with easily distinguished characters and will, no doubt, be in a position to distribute some of these lines for multiplication within a few years.

TABLE 66.—PURITY OF G. 79 RICE GROWN AT VARIOUS STATIONS

<i>Station</i>	<i>Description</i>	<i>Mature pure seed percentage</i>	<i>Immature pure seed percentage</i>	<i>Others percentage</i>	<i>Germination percentage</i>
Ilorin ...	G. 79 ex Pategi	95	3	2R	98
Barakin Ladi ...	G. 79	90	—	4R, 6E	98
Sokoto ...	G. 79	83	9	12R	83
Bida ...	G. 79 ex Badeggi	71	—	26R, 3S	88
	G. 79 ex Edozhigi	84	3	11R, 2S	88
Maiduguri ...	G. 79	88	7	5R	78
Shendam ...	G. 79	89	8	2R, 1S	97
Yola ...	G. 79 Stage 0	91	5	4R	91
	G. 79 Stage 1	89	7	3R 3G	92
Maigana ...	ex Bida Stage 0	90	9	1S	72
	ex N. Prov. Stage 0	87	11	2S	88
	ex Yandev Stage 0	92	5	3S	84
	ex Sokoto Stage 0	81	19	—	82
	ex Yola Stage 0	93	13	—	82
	ex B. Guiana	84	14	2S	87
	Stage 1	93	6	1S	88

Where R=red: S=off-type in shape: E=empty: G=grey.

M.—RAMA (*HIBISCUS CANNABINUS*)

In 1955 six newly imported varieties of Rama were grown on the Botany farm stock plots. They were Egyptian A and B, Sudan 1 and 2, Brazilian and San Salvador.

The plants were adversely affected by an attack of small beetles when 4 to 5 inches in height. An application of Agrocide 3 dust reduced the insect population but although the plants recovered to some extent, they never got over their set-back. San Salvador and Egyptian "A" were particularly badly affected.

Fibre yields were, unfortunately, not recorded here but on the basis of height and average number of branches per plant, the Sudan 1 variety

would appear to be best. The other varieties are of interest to us in that they mature at an earlier date and should a fibre industry be established in the region it would be of great value to the mill to have a supply of fibre coming in over a period of time rather than all at once.

In 1956 the varieties will be grown again and a planting sequence will be carried out.

N.—CASSAVA (*MANIHOT UTILISSIMA* AND *M PALAMATA*)

Owing to an attack of *Fusarium equisiti*, much of the cassava being grown in 1954 had to be destroyed. This heavy roguing left only enough material to plant maintenance plots of each variety and meant that no cassava trials could be conducted in 1954-55. However, these maintenance plots produced sufficient material in 1955 to plant three cassava experiments. These trials, Cassava Mosaic Yield Trial, Cassava Clones Yield Trial and Cassava Length of Cutting Observation, are now growing in the field and will be harvested this June. This late harvest date means that the results of these three trials can not be reported until next year.

COWPEAS (*VIGNA UNGUICULATA*)

Two Cowpea Variety Yield Trials were conducted this year, one at Samaru and one at Kano. Owing to late plantings and the early cessation of rains, the yields in these two trials were too low to justify statistical analysis.

A questionnaire to determine the "ideal" cowpea variety required in each district was circulated to the Agricultural Stations in the Northern Region. The answers indicate that the most generally acceptable variety would fit the following description:

The variety would be a late maturing, high yielding, white seeded type. Its seeds might be either large or small but must be suitable for human consumption. This variety should be of a trailing vine type although some localities desire a bushy type. However, the vines and leaves should be suitable for cattle food. In several districts, root knot and wilt resistance are also important.

In an attempt to develop an improved cowpea variety, a backcrossing programme has been initiated. The purpose of this programme is to incorporate the desirable white seed character into the high yielding, coloured varieties Mauritius and New Era.

O.—SWEET POTATOES (*IPOMOEA BATATAS*)

Twelve sweet potato varieties have been grown for several years at Samaru in maintenance and observation plots and have generally given good yields. These twelve varieties will be grown in a Variety Yield Trial this coming year and tests will be made to determine the most desirable root types.

P.—YAMS (*DIOSCOREA* SP)

This crop is assuming more importance in the Northern Region with increasing quantities being grown here. Most of the local varieties are ones which have been brought up from the south of Nigeria, with the result that little is known of their performance here. Therefore, in this coming year, local Zaria yam varieties are being grown at Samaru for observation and selection.

Q.—OTHER FOOD CROPS

It has been recognised for many years that consideration must be given to the "minor" food crops if the level of the Nigerian diet is to be raised. Now that more staff has been appointed to the Botany section, these "minor" food crops will be given more intensive study.

The procedure which has been adopted for the improvement of these crops included the following points:

(a) The material already on hand is being re-evaluated. This involves the following:

- (i) determining further its yielding ability.
- (ii) describing its agronomic and varietal characteristics including disease and insect resistance.
- (iii) testing the quality, palatability, and nutritive value of its produce.

(b) New stock is being incorporated into the programme through the introduction of local and foreign plant material and varieties. These introductions must also be observed and their performance evaluated when grown under our conditions.

(c) Selections will be made, from all this material, of the most promising varieties or single plants.

(d) This selected material may either be tested and multiplied up for distribution and testing at outstations, or it may be used as breeding material in a breeding programme.

(e) Questionnaires are being circulated to ascertain which characteristic should be selected and incorporated into each crop.

R.—NATIVE VEGETABLES

A questionnaire on native vegetables was sent to all districts to obtain the following information:

- (i) name and origin
- (ii) extent and method of cultivation.
- (iii) methods of preparation, uses of the crop and its popularity and nutritive value.

A request for seed samples of these crops was included with the questionnaire and the seed received will be grown at Samaru this coming year for observation and evaluation.

EXOTIC VEGETABLES

Observation trials were conducted throughout the year on many exotic vegetables. Special attention was again given to tomato varieties as these generally grow well here.

STOCK PLOTS (A.R.M.)

An ever-increasing number of varieties, strains and selections of all crops is being maintained in the stock plots. These crops must be grown every year as seed may deteriorate if kept a longer time. Ideally this large collection should be grown only once in every two or three years, but storage facilities are inadequate at present to cope with this. It is hoped that funds will be available in the future for the construction of an air-conditioned cool-storage room.

The stock-plot yields were satisfactory for most crops in 1955. Some crops suffered from water-logging in the lower-lying parts of the fields.

S.—NURSERY AND ORCHARD

Propagation.—The most significant improvement in propagation has been effected by the introduction of polythene plastic budding tape. Trials were conducted at Samaru to compare the effectiveness of the plastic tape and the ordinary rama fibre used previously. The observations were made over several weeks to determine the best time for budding. The results are shown in Table 67 and prove conclusively that plastic tape is effective and that the optimum time for mango budding is in May to June. This information has been circulated and orders for plastic tape are being placed at all stations.

TABLE 67.—BUDDING OF MANGOES WITH PLASTIC TAPE AND RAMA FIBRE, SAMARU

Date				Plastic Tape			Rama Tape		
				Budded	Taken	Take	Budded	Taken	Take
January	...	...	...	—	—	—	58	0	0
February	...	...	...	—	—	—	155	0	0
May 11-20	...	...	...	89	73	82.0	57	6	10.9
May 21-31	...	...	...	59	37	62.7	16	0	0
June 1-10	...	...	...	89	68	76.4	—	—	—
June 11-20	...	...	...	38	32	84.2	—	—	—
June 21-30	...	...	...	—	—	—	—	—	—
July 1-10	...	...	...	21	10	47.6	—	—	—
July 11-20	...	...	...	—	—	—	—	—	—
July 21-31	...	...	...	11	2	18.2	—	—	—
Totals	...	...	...	307	222	72.3	286	6	2.1

The plastic tape can be used successfully for citrus as well as mango budding. Detailed instructions on the method of application are being sent to all outstations.

Mango Root Stocks.—In order to determine the effectiveness of several types of local mangoes as root stocks for budding, beds of the different types have been sown and will be budded in 1956. There is every possibility that certain types will be more compatible than others. This is of necessity a long-term project and results will not be available for several years.

Citrus Root Stocks.—The use of Rough Lemon as a root stock has long been recommended in the North, but information is not available on the effectiveness of Lake and Sampson Tangelos. Seedling Tangelo trees are very vigorous and markedly drought resistant. To determine their value as root stocks, preparations are in hand for the establishment of a series of trials, at stations throughout the region in 1957. Seeds are being grown now at Samaru for budding in 1956, and transplanting in 1957.

Distribution.—The demand for budded fruit trees, pawpaws and ornamentals continues to be higher than the available supply. During the year plants were sent to many parts of the Northern Region as well as French West Africa.

New compounds at Samaru are being established and require much material in the way of ornamentals, hedges, shade trees and fruit trees.

Avocado Pear.—A shipment of Avocado Pear bud wood was received by air from South Africa. Although these were delayed for three days in Kano by the internal airways, the material appeared to be in good condition on arrival at Samaru. Grafting and budding was done immediately and within a week a high proportion of the plants appeared to have taken successfully.

A month later all but one plant were dead and that has since perished. It would appear that the only way to introduce good named varieties is to import whole plants.

Seedling avocados are doing well at Samaru but take many years to come into bearing.

Introductions.—A total of 665 introductions as listed in Table 68 were received at Samaru during the year under review.

TABLE 68.—INTRODUCTIONS RECEIVED BETWEEN 1-4-55 AND 31-3-56

				<i>No.</i> <i>received</i>	<i>Source</i>
<i>Crop</i>					
Guineacorn	...	...	...	25	Maradi, French West Africa
Guineacorn	...	...	...	15	Gold Coast
Guineacorn	...	...	...	522	Sudan
Guineacorn	...	...	...	1	Belgian Congo
Guineacorn	...	...	...	2	South Africa

TABLE 68.—INTRODUCTIONS RECEIVED BETWEEN 1-4-55 AND 31-3-56—*conid*

<i>Crop</i>				<i>No.</i> <i>received</i>	<i>Source</i>
Groundnuts	...	...	...	34	Maradi
Groundnuts	...	...	...	4	Sierra Leone
Groundnuts	...	...	...	5	Tripoli
Millet	...	...	...	7	Maradi
Millet	...	...	...	1	Belgian Congo
Sugar Cane	...	...	...	5	Ibadan
Wheat	...	...	...	22	Hungaria
Grass	...	...	...	3	South Africa
Maize	...	...	...	2	American Missionary
Pecans	...	...	...	5	United States of America
Persimmons	...	...	...	1	United States of America
Beans	...	...	...	1	Europe
Tarriba	...	...	...	1	Uganda
Avocado Pears	...	...	...	9	South Africa

The large numbers of sorghum varieties from the Sudan represent almost the entire collection developed there by the Agricultural Department. Further shipments of other crops are expected from the Sudan in the near future.

BOTANY AND PLANT PATHOLOGY LABORATORY

(W. R. WILSON)

During the year the following were among the duties carried out by the Laboratory staff.

Germination Test of Seeds.—Various farm and ornamental seeds were tested for the Botanist and Agronomist.

Groundnut Seed Size Germination Observation.—The grading of the seed into ten different sizes followed by germination tests were carried out for the Groundnut Breeder.

Rice Purity Test.—Samples to rice received from out-stations were examined for purity and germination tests.

Fumigation of Seeds.—All seeds being sent from Samaru to stations in other countries were fumigated as required by regulation.

Cotton.—Preparation of media and bacteriological plates were made for growing *Xanthomonas malvacearum*. These were inoculated from infected cotton plants and grown in the Laboratory, The cultures later being used by the Cotton Breeder in the field.

Blindness in Groundnuts.—Media and plates were made and infected from blindnuts received from Bida. From the cultures grown in the lab. fresh seed were inoculated.

A start was also made of microtome sectioning and staining of tissue from blindnuts. This is to be continued in more detail next season.

Museum and Herbarium.—Many specimens of plants showing damage by pests and diseases were added to the collection also one case of economic insect pests was added by the Entomologist.

Milk for the Royal Visit.—During the visit of Her Majesty the Queen to Kaduna, all milk which was delivered from Shika to Government House was tested in the laboratory, by Plate Counts and MacConkey's method. The tests showed that after pasturisation the milk was of a higher standard than required by law in the United Kingdom.

Glasshouse.—The glasshouse has been completed and divided into four sections, the roof of each section having a different ratio of glass to asbestos, in an effort to produce the most favourable range of light intensities.

In the short time the house has been in use, it has been found that the asbestos is warping and cracking, also it has been necessary to whiten the glass to give partial shade.

Soil Block Machine.—This has been added to the equipment and has already been used extensively. At present different mixtures of soil and compost are being experimented with to find the most suitable.

Soil Sterilizer.—A small model by G.E.D. is in use. This is large enough to supply sufficient soil for the Soil Block Machine, but is too small to cope with the large amounts required for flower pots. A larger model is being indented for this year.

PLANT PATHOLOGY

GUINEACORN (SORGHUM VULGARE)—(E. HARRISON)

Identification of pathogens causing leaf spots on guineacorn at Samaru was started in November. (It is hoped eventually to assess the relative importance of the commoner leaf spots of sorghum and to estimate their effect on yield). Guineacorn plants available at this time were fully grown or dying, but a number of fungi were isolated successfully. The prevalent leafspots under these conditions were grey leaf spot, *Cercospora sorghi*; anthracnose, *Colletotrichum graminicola*; rust, *Puccinia purpurea*, and dead lesions of sooty streak, *Ramulispora sorghi*. Zonate leaf spot, *Gloeosporium sorghi*; leaf blight, *Helminthosporium turcicum*, downy mildew, *Sclerospora sorghi* and *Ascochyta sorghina* were also present and *Eudaruca australis* was common paratizing rust uredosori. Fungi isolated from several other leaf spots have not yet been identified.

Suspensions of spores from cultures of a number of these fungi were used to inoculate guineacorn seedlings grown in soil blocks in the greenhouse. In most cases infected leaves died before the leaf spots were fully developed but *Ascochyta Sorghina* produced pycnidia and soppres. These inoculations are being continued.

Fungi on the grain of blighted guineacorn heads from variety trials at Gusau and Samaru were also studied. The included five species of *Curvularia*.

MILLET (*Pennisetum typhoideum*)

Ergot sclerotia, the overwintering stage of sugary disease, *Sphacelia* sp., were found in millet seed from the 1955 stock plots at Samaru. The sclerotia made up 2-3 per cent by weight of the samples. This disease was first noticed at Samaru in 1954 when several stock plots were heavily infected and the heads were burnt and fresh seed obtained. The disease is difficult to control as infection starts from sclerotia planted with the seed or left lying on the ground and is spread rapidly by insects attracted to the honeydew. Infection can be especially serious at Samaru where different varieties of millet are flowering over a long period. In addition to contamination of grain by sclerotia, which are highly toxic, yields are lowered because *Sphacelia* causes sterility in a large number of spikelets on infected heads.

It was thought that ergot sclerotia could be separated from millet grain by floating them off in water. However, it has been found this year that many sclerotia float in water because they are hollowed out by insects, while small fragments and sound sclerotia sink. Samples of sclerotia were separated from millet and their specific gravity was found to be 1.07 as compared with 1.30 for grain. All the sclerotia float in brine of specific gravity about 1.1 and it is hoped to use this method to remove sclerotia from millet seed for planting at Samaru.

SUGAR CANE (*Saccharum officinale*)

A series of inoculations of sugar cane varieties with *Colletotrichum falcatum*, the fungus causing red rot, was carried out in May 1955. The plug method was used and inoculated canes were harvested six months later and split open to find the spread of infection. Of twenty-three varieties tested the four varieties:—

POJ	...	...	...	...	...	...	...	2725
CO	...	...	...	...	...	...	...	543
CO	...	...	...	...	...	...	...	281
CO	...	...	...	...	...	...	...	413

were found to be most resistant to the spread of infection and are being multiplied.

A special plot of sugar cane for further inoculations is being planted.

MAIZE RUST ASSAY

Three maize rust assay plots were planted at Samaru for the West African Maize Research Unit on 9-5-55, 6-6-55 and 4-7-55. These are the last maize rust assay plots to be planted at Samaru. Results have been sent to the Unit.

Laboratory Investigation.—Routine investigations of other plant diseases at Samaru and from outstations included the following:—

Tolyposporium chrenbergii, long smut of guineacorn, was collected at Daura. This smut seems to be troublesome only in the lower rainfall areas of the region,

Sphacelia sorghi, the sugary disease of sorghum, occurred on guineacorn at Gusau. It does not appear to have been recorded previously in Nigeria. Sclerotia similar to those on millet were formed and these will be floated off in brine from guineacorn seed for planting at Gusau. There are indications that the disease may also be present at Samaru.

Orange fruits in the N.A. garden at Gusau were affected by sun spot in the 1954-55 dry season.

Several specimens of rice with leaf spots and poorly filled or empty heads from various parts of Plateau Province were examined. Conidial *Ophiobolus miyabeanus*, brown spot, was present on most of the samples, in addition to some minor rice pathogens. It was uncertain whether the *Ophiobolus* alone was the cause of these symptoms and it is hoped to investigate the condition in the field next season.

Ustilaginoida virens, false smut, was also identified on rice from Plateau Province.

A small sample of rice from Plateau Province tested for deterioration was found to be heavily infected with saprophytic fungi, especially *Mucor sp.*, and did not germinate.

Three newly introduced Australian varieties of tomatoes growing in the Botanists' Farm in April, 1955, developed a severe leaf curl accompanied by distortion of young growth and early abscission of fruits. A virus disease was suspected to be the cause.

Tomato plants at Kano Farm Centre in May, 1955 suffered from wilting caused by a heavy infection of root knot eelworm. The eelworm was indentified by Dr Franklin at Rothamsted as *Meloidogyne incognita*.

A bud rot of date palms, the cause of which was not determined, occurred at Kiba in Kano Province.

Several banana plants at Maska and at Samaru which showed incomplete emergence of the inflorescence were investigated. This condition has been noticed sporadically during the last few years. The true stem does not emerge normally from the pseudostem so that bunches are often horizontal or only the tips emerge. When the pseudostem is cut open the true stem is found to be severely distorted and often bent completely back on itself just before the point of emergence. Often rot starts at the distortion and the plant collapses; in most cases the fruit does not ripen properly. The cause of this disorder is unknown, it may be due to unfavourable growing conditions; similar symptoms are caused by bunchy top, a virus disease, but the leaf symptoms also associated with bunchy top have not been detected.

GROUNDNUT PATHOLOGY—(R. E. WILSON)

The diseases of groundnut investigated during the year were Rosette and Blindnuts. *Cercospora* Leaf Spot was observed throughout the Region but was nowhere serious. Early maturing types in wetter areas appear to suffer most.

Rosette.—Rosette incidence during the year was about average. Most crops in the North had negligible or no infection but late planted crops in the Middle Belt were seriously affected. As stated elsewhere in this report groundnuts at Kontagora showed up to 90 per cent infection.

An aphid survey was made in November but very few colonies were found and all these were found on ground-keepers in old groundnut fields; the overwintering of the aphid requires further investigation.

* *Blindnuts*.—The malady known as Blindnuts has now been reported from Bida, Daura, Dambarta, Gaya, Mafara and Yola. The symptoms range from apparently healthy kernels with internal discolouration to completely undeveloped kernels ("pops" in the U.S.A.). Bacteria have been isolated from the discoloured kernels and have been indentified as *Pectobacterium* (*Bacterium*) *aroideae*, *Bacillus subtilis* and two strains nearly indentical coliform and not yet identified with any species. (Identification by Dr Dawson of Cambridge).

Inoculation tests were carried out at Samaru with the isolated bacteria on groundnut seeds. Three treatments and a control were used.

(a) The seed was smeared with bacteria from a culture.

(b) The seed was imersed in a suspension of the inoculum.

(c) The plants as they grew were watered with a suspension of the inoculum.

(d) Control—no treatment.

The soil used in the pots was unsterilized Samaru soil.

The result in all cases was negative, no characteristic symptoms being produced.

An observation experiment was laid down at Bida, to indicate if there was any association of blindnuts with rosette and/or fertility levels. There were four main plots.

Plot 1	...	...	...	...	...	Sprayed—no manure
Plot 2	...	...	...	...	...	Sprayed and manured
Plot 3	...	...	...	...	...	Unsprayed and manured
Plot 4	...	...	...	...	...	Unsprayed and no manure

Sprayed plots were sprayed with Gammalin 20 at 1½ pints in 30 gallons of water per acre. Manured plots received 112 lbs. per acre Superphosphate. During the growing season two plants from each plot were taken at fortnightly intervals and the amount of blindnut infection was determined. It was found however, that the variation in the samples was very large and so no definite trends were observed.

At the end of the experiment a final assaying of blindnuts was taken on 400 nuts from each plot. The final results are listed in Table 69.

TABLE 69

<i>Treatments</i>	<i>Yield kernels lb/acre</i>	<i>Blindnut</i>	<i>Final rosette count</i>
Sprayed +super	892	35	390
Sprayed no super	548	33	254
Unsprayed +super	780	41	1046
Unsprayed no manure ...	396	48	1831

It is seen that spraying controlled the rosette and also ameliorated the percentage of blindnut infection but that the yield response followed manurial treatment to a greater extent than spraying. Mean response to Superphosphate was 364 lb. per acre, while mean response to spraying was 132 lb. per acre.

Blind nuts in Daura—D.N.P.K. Trial.—It was noted that the amount of blindnuts in this experiment reported under the Chemistry Section, varied from plot to plot. Accordingly an assay of 100 nuts from each plot of this experiment was made and the results of the analysis are listed in Table 70.

TABLE 70.—SAMPLE BLINDNUT COUNTS IN D.N.P.K. TRIAL, DAURA

<i>Treatments</i>	<i>Blindnut Totals</i>
F.Y.M.	***
Nil	1981
1 ton/acre	1129
2 tons/acre	541
<i>Sulphate of Ammonia:</i>	***
Nil	506
50 lb./acre	1437
100 lb./acre	1707
<i>Superphosphate:</i>	***
Nil	2213
50 lb./acre	869
100 lb./acre	569
<i>Muriate of Potash:</i>	
Nil	874
25 lb./acre	1179
50 lb./acre	1599

INTERACTIONS

DxN				DxP			
D 0	D 1	D 2		D 0	D 1	D 2	
797	430	292	N 0	P 0	3502	2017	1119
2440	1287	585	N 1	P 1	1469	820	319
2706	1670	746	N 2	P 2	971	551	185

DxK				NxP			
D 0	D 1	D 2		N 0	N 1	N 2	
1203	921	497	K 0	P 0	992	2796	2850
2010	1109	417	K 1	P 1	259	1039	1311
2729	1358	709	K 2	P 2	269	477	961

S.E. $\pm$ 193

Interactions NxK and PxK not significant.

Blindnuts in Danbatta, Trace Element Trial.—This experiment of phosphate and trace elements on groundnuts is more fully described in the report of the Chemistry Section. An analysis of blindnut infection gave the results listed in Table 71.

TABLE 71.—BLINDNUT INFECTION COUNTS, DANBATT A TRACE ELEMENT TRIAL

<i>Treatments</i>	<i>Transformed Results</i>
Nil	42.29
Super at 112 lb.+56 lb. Sulph. Ammonia	38.08
Trace Elements	35.45
Trace Elements + Super = Sulph Ammonia	25.41
S.E.	$\pm$ 3.64
5 per cent Significant difference	10.97

There were also included in this experiment two observation plots one receiving N.P.K., Trace Elements and Awgu lime, the other N.P. Trace Elements and Awgu lime. The former had the lowest percentage of blindnut infection in the whole experiment and the latter the second lowest. In the experiment as analysed, trace elements + Super + Sulphate of Ammonia, significantly reduced the number of blindnuts. This effect of fertility level of blindnuts is also seen in the Daura experiment. Because of the effect of fertility it is considered that blindnuts are primarily a manifestation of the nutrient status and that the bacterial infection is secondary.

Some support for this view is given by the fact that a non-significant regression of "pops" to discoloured kernels was obtained. ($t=1.86$ for 79 degrees of freedom).

A highly significant negative correlation was obtained ($P=.001$) between blinduts and shelling percentage as is to be expected. Ax^2 test showed a highly significant *** deviation from a 1: 1 ration between infection of kernels in the pod. The results showed that the kernel farthest from the gynophore had a greater tendency to exhibit symptoms.

III. COTTON BREEDING AND SELECTION

By H. E. KING

(The following report called for and produced before the completion of laboratory work and full analysis of all data, is to that extent incomplete. Full results will, as usual, be published in the Empire Cotton Growing Corporation's Progress Reports from Experiment Stations, 1955-56 Season. J.H.G.)

INTRODUCTORY

The season was a difficult one in several respects. A large programme of work was undertaken and after its commencement the junior staff situation, never satisfactory, took a dramatic turn for the worse. Nine subordinate workers with up to six years careful training in the techniques of cotton breeding work had their contracts terminated and were reduced to daily paid employees on inferior terms. One agricultural assistant resigned and was not replaced and there were also difficulties with field labour.

Towards the end of the season the services of the assistant agricultural officer were lost through his temporary transfer to relieve acute staffing difficulties elsewhere.

The weather at Samaru (and also through Zaria, Katsina and Sokoto Provinces) was not favourable to high yields of cotton. Excessive rainfall and consequent waterlogging (common at Samaru in August in most seasons) continued this season until late September. The rainfall total for the three months July-September was indeed a near record at Samaru and far more than is needed to nourish a crop of cotton during its early growth.

The subsequent onset of the completely rainless cool weather with the extremely low humidities, characteristic of the Northern Nigerian winter, was not correspondingly delayed. It was in fact about three weeks earlier than last season. In consequence the relatively humid, but warm and sunny period usual between the rains and the "harmattan" was curtailed. The duration and character of this intermediate period is believed to be of outstanding importance to the fruiting of the cotton plant though studies directed to confirming or disproving this by statistical evidence have not yet been successful.

Observations showed that flowering commenced late and boll setting was poor and erratic without a well-marked flush. In consequence the crop was late and final yield was attained by the retention and maturing of bolls from flowers produced sporadically well into December.

These difficult fruiting conditions magnified the usual plant to plant and plot to plot differences in cropping and also produced some substantial modifications or even reversals in the relative yields of strains and of plots subjected to differing treatments.

The general incidence of insect pests at Samaru did not appear notably higher than usual but there is evidence that more loss of crop was caused by insect damage, perhaps because the normal powers of recovery of the cotton plant were already taxed to the limit.

The same conclusion applies to disease damage. Bacterial blight (*Xanthomonas malvacearum*) was not conspicuously more in evidence than in most seasons but the protection afforded by seed disinfection appeared to result in some increase in yield (in contrast to last season).

Sustained critical work on this disease had to be further delayed due to lack of accommodation at Samaru for the newly recruited Plant Pathologist.

In spite of the difficult conditions discussed above the final yields at Samaru, after a long drawn out picking period, were not in general greatly below those of last season. Yields of 600-800 lb. of seed cotton per acre were obtained from the various multiplication plots; experiments (less well treated) gave 450-600 lb. There was certainly no universal depression comparable to that shown by the commercial crop of Zaria and Katsina Provinces.

At other stations also the yields on departmental farms were not heavily depressed and in some stations were indeed above last season's (e.g. Maigana). At Daudawa yields up to 650 lb. of seed-cotton per acre were recorded.

A general conclusion which may perhaps legitimately be drawn from the season as a whole, over the greater part of the cotton belt, is that the weather was such that failure to follow the rules of good cultivation incurred a heavier penalty than usual.

Hybridization.—The programme of hybridization, briefly referred to in last season's report, was continued and the required crosses were successfully made. No details of this work can usefully be presented at this stage. It is of interest however to note that some hybrid single plants, showing presumably a very substantial degree of "hybrid vigour", were able to yield as much as $\frac{3}{4}$ lb. of seed cotton per plant in this difficult season.

An experiment was carried out to give some rough guide to the general level of natural outcrossing which takes place at Samaru. For this several different marker types were imported. Preliminary results suggest that the amount of outcrossing is high. It is fully realised that these results suffer

from the objection that crossing between widely different types is a poor guide to crossing within a single strain. A commencement has therefore been made in breeding a local marker type differing from the 26C only in the possession of a marker gene.

Replicated Progeny Row Tests.—Two large tests of progenies were carried out. The first followed what has become the established design here, a balanced incomplete block design accommodating forty-nine treatments in eightfold replication with a plot size of 1/1000 acre (nine stands of cotton, one plant per stand at 18 inches spacing on a 3-foot ridge).

This experiment showed a high standard of precision for so small a plot size, the coefficient of variation being only 17 per cent. The magnitude of the differences between progenies was, however, disappointing. It was concluded that the season was against the expression of real differences; the 26C/49160-23 progenies (which comprised one third of the total in the test) did surprisingly poorly.

Nevertheless, significant differences in plant characters were brought out and useful comparisons of the importance of the separate components of yield were possible. Lint per seed appeared the most influential single character; bolls per plant were of more importance than seeds per boll.

The second of the two trials was much larger and on less orthodox lines. It contained 120 progenies each replicated only four times but with each plot accompanied by a control line of a standard strain. This enabled analysis of covariance to be employed to adjust observed yields. The coefficient of variation after this adjustment was no larger than that of the much smaller test described above (viz. 17 per cent).

In this test wide differences in yield occurred: the progenies were all derivatives of the line 26C/479-25 and the test was most useful in establishing that significant differences existed within this material.

Small Bulks Test.—Forty-nine small bulks in a replicated test of material from the previous season's progenies gave interesting but rather disappointing results. One third of the selections included were derived from the 26C/49160-23 line; material showing high yield with notably early cropping and very good lint quality.

It appears that the season was unsuited to this type; almost all these derivatives gave poor yields relative to 26C and 26J. This result was in keeping with the behaviour of 26C/49160-23 B.C.P. in the Strains Test and some of the District Variety Tests (See later).

There were some quite severe losses of seedlings in a number of lines in this experiment during the early weeks of growth. These were associated with difficult growing conditions (excessive rainfall and partial waterlogging) but were very irregularly scattered and strongly suggested differing susceptibility of related lines of material to some specific but unidentified

cause of seedling mortality. Final stands of several lines were so reduced as to render their yield figures useless. This is the second season in which sporadic losses of this nature have occurred; plans have been made for an investigation into the cause.

Strains Test.—Twenty-one strains, chiefly of 26C derivation but including some introduced types, were tested in a balanced incomplete block design with ten replications. Yields were high, the control 26C gave over 600 lbs of seed-cotton per acre, but as a comparison of strains the test was disappointing. Differences between the various 26C derivatives were in general small and out of keeping with their previous history. It seems probable that the conditions of growth interfered with the expression of varietal characteristics displayed in a more normal season obscuring the differences between related types and reversing some of the comparisons between those of more widely different origin and fruiting characteristics. MU 8A for instance, normally a substantially higher yielder than 26C, was this season significantly lower yielding. This did not appear to be due to its known greater susceptibility to bacterial blight; this disease was not conspicuously more in evidence than in previous seasons. MU 8 is, however, a notably early cropper, one of the earliest amongst all strains grown at Samaru. The greater part of the crop from the experiment came from fruit set after the middle of October and under these conditions apparently 26C types were at a distinct advantage.

Other imported types, Uganda BP 52, BAR 7/8.2, and Punjab 268F (brought in as a potential high yielder) also yielded significantly below local strains but one Albar type (Albar 51/645) equalled 26C in yield.

District Variety Tests.—The standard series of replicated tests of eight strains was continued. The seed-cotton yields, station by station, are listed in Table 72 while Table 73 gives the combined results both as seed-cotton and as ginned lint. For these combined results it was considered preferable to omit the Maiduguri figures this season. The test there gave the astonishing yield, averaged over all eight strains, of approximately 1170 lb. of seed-cotton per acre. It is clear that the conditions there are in some way very different indeed from those general throughout the cotton belt. As noted in previous reports the experimental farm there appears to have supplies of underground water which make it quite unrepresentative of normal "upland" farming conditions in Northern Nigeria. It is possible that an important contribution to the cotton crop of Bornu (and perhaps Northern Kano and Katsina also) could come from such favoured patches of land but the time has not yet arrived when the variety testing programme should take them into account. It is hoped to move the Maiduguri test on to more representative land next season.

TABLE 72.—DISTRICT VARIETY TESTS SEASON 1955-56,
SEED-COTTON YIELDS FROM ELEVEN EXPERIMENTS

<i>Experiment (with yield of control type in lb per acre given in brackets)</i>	<i>Yield of the other Seven Strains expressed as percentage of the control type (New Issue 26C)</i>							<i>S.E. ±</i>
	<i>First Wave 26J</i>	<i>479-25 B.C.P.</i>	<i>479-25 -44</i>	<i>479-25 -97</i>	<i>49160- 23 B.C.P.</i>	<i>26I/25</i>	<i>D5/33 -4</i>	
Samaru Timely (552)	104	109	108	104	99	98	103	4.6
Samaru Delayed (459)	115	116	116	105	102	116	109	6.7
Daudawa Timely (236)	123	137	108	107	79	100	97	13.2
Daudawa Delayed (113)	96	116	108	121	81	93	102	15.5
Gombe Timely (405) ...	112	107	105	113	108	111	113	6.0
Gombe Delayed (339)	109	111	122	99	116	115	110	5.6
Gusau (559) ...	101	100	100	93	88	94	88	3.8
Kano (342) ...	115	110	120	110	116	126	135	8.4
Kontagora (132) ...	101	113	111	109	103	122	116	8.7
Zonkwa (323) ...	103	110	98	114	106	90	86	7.1
Maiduguri (1169) ...	93	102	97	103	101	102	101	2.5

TABLE 73.—DISTRICT VARIETY TESTS SEASON 1955-56,
COMBINED RESULTS FROM TEN EXPERIMENTS

<i>Strain</i>	<i>Seed-Cotton Yield in lb. per acre and (in brackets) as percentage of Control Type</i>		<i>Gin Per cent</i>	<i>Lint Yield</i>	<i>Lint Length</i>
	<i>(a)</i>	<i>(b)</i>	<i>(c)</i>	<i>(d)</i>	<i>(e)</i>
"New Issue" 26C ...	345 (100)	333 (100)	35.4	122 (100)	33.2
First Wave 26J ...	374 (108)	354 (106)	34.9	131 (107)	33.6
26C/479-25 B.C.P. ...	383 (111)	365 (110)	34.4	132 (108)	33.8
26C/479-25-44 ...	377 (109)	360 (108)	36.0	136 (111)	34.4
26C/479-25-97 ...	364 (106)	353 (106)	35.4	129 (106)	33.8
26C/49160-23 B.C.P. ...	348 (101)	336 (101)	35.0	122 (100)	33.4
26I/25 ...	366 (106)	347 (104)	36.1	132 (108)	32.7
D5/33-4 ...	363 (105)	341 (102)	35.4	129 (106)	33.2

(a) Simple arithmetic mean of yields at ten sites.

(b) Weighted mean (yields with highest errors given least weight following Cochran's method of "Partial Weighting", Biometrics Vol. 10, No. 1).

- (c) Arithmetic mean of the separate percentages from the ten experiments.
- (d) Pounds per acre calculated from columns (a) and (c).
- (e) Millimetres, Bailey Halo, mean of 320 seeds (32 from each site).

The figures set out in Table 72 show that, in spite of the usual variations from site to site with occasional really wide discrepancies, the derivatives of 26C/479, whether taken separately or combined together as “first wave 26J”, have given higher yields than the control. This control was the “New Issue” 26C stock which was shown in last season’s series of tests to be an improvement on older stocks of Samaru 26C.

Comparisons of the three 26J components amongst themselves, and against the mixture of the three, show only small and inconsistent differences in seed-cotton yield. The substrains 479-25-44 and 479-25-97 both have higher ginning percentages than 479-25 B.C.P. (see Table 73) and on average 479-25-44 seems to be just appreciably better than 479-25-97 in seed-cotton yield and superior to 479-25 B.C.P. also when lint yields are considered. However, recent spinning test results (reported in 1954-55 Progress Report published by the Empire Cotton Growing Corporation) show that 479-25-44 is inferior in spinning quality to 479-25 B.C.P. and 479-25-97 while the two latter are indistinguishable in length, hair weight and yarn strength and both a marked advance on Samaru 26C in quality.

On balance therefore it seems wise to discount the possibly superior yielding power of 479-25-44 and let the other two components go forward together as the new stock of Samaru 26J.

As noted earlier in this report the strain 26C/49160-23 B.C.P. has done poorly this season compared to its promise in previous tests. It seems clearly a less consistent good yielder though its earliness and high quality merited attention. Further reselections from it may yet justify themselves.

The remaining two strains in these district tests, 26I/25 and D5/33-4 proved this season to be in no way outstanding as competitors of 26J. Both are later cropping types capable of big yields under some conditions. Their much greater variation in yield from site to site, relative to 26C and 26J, is noteworthy.

The data accumulating from these annual series of district tests are providing some most interesting sidelights on the effect of locality on crop. Each station is supplied with exactly the same seed of each of the strains under test and the produce is all sent to Samaru for ginning so that within any one season valid “locality” comparisons are possible.

Over four seasons the figures show some consistent trends. Kano, Zonkwa, Gombe and Kontagora have tended to give longer lint than Samaru, Daudawa and Gusau. Ginning percentages have varied quite widely tending to be higher at Samaru and Zonkwa than at Daudawa and Gombe. Maiduguri ginning percentages are strikingly low.

Small samples of seed-cotton from the commercial crop obtained annually from a series of chosen markets scattered over the cotton belt are likewise showing appreciable locality effects but their full examination is not yet completed.

Maigana Cotton Variety Test.—Experiments run at Maigana in two previous seasons, as part of the series of district variety tests, gave such very poor yields and such extremely high standard errors as to provide no useful varietal comparisons. In the 1955-56 season, therefore, the experimental design was modified. Only four strains were included, chosen as likely to show the widest differences in yield, and these were replicated sixteen times.

Yields were very much higher this season (the experiment was on a better drained field) but lightning struck and damaged many of the plants in nine of the plots. This damage was unequally distributed over the four strains and without some adjustment for this, the yield data as a whole are of doubtful value.

Two strains, however, were damaged less severely and apparently about equally and as it happens these two provide a comparison of particular interest. Figures for these are therefore presented in Table 74 below together with a standard error calculated as though the experiment had been one of sixteen randomised blocks of two strains only.

“Mai Inchi Allen” represents the commercial crop of the Region of ten years ago, before the introduction to the farmer of Samaru 26C and its derivatives, while “First Wave 26J” represents the latest of these derivatives to go into multiplication for Region-wide distribution. The figures speak for themselves.

TABLE 74.—DATA FROM MAIGANA VARIETY TEST
Yields in lb. per acre, seed-cotton and lint

<i>Strain</i>				<i>Seed-Cotton</i>	<i>Gin %</i>	<i>Lint</i>	<i>Lint Length</i>
Mai Inchi Allen	...	...	...	411 (100%)	31.6	130 (100%)	31.5 mm.
First Wave 26J	...	...	...	582 (142%)	35.1	204 (157%)	33.6 mm.
S.E.	...	...	...	±25.3(6.2%)		8.4±(6.5%)	

Seed Multiplication.—The usual series of seed multiplication plots of appropriate sizes was grown at Samaru. Yields were quite satisfactory: smaller plots averaged from 500 to 800 lb. of seed-cotton per acre while larger plots (one acre and upwards) gave yields of 400 to 670 lb. per acre according to site, cultural treatment and variety.

One two-acre field which averaged 650 lb. of seed-cotton per acre was carrying its fourth successive cotton crop and its eleventh consecutive arable crop as a portion of the research station. Before being taken over in 1945-46 it had grown guineacorn for a number of years. Unfortunately with the new soil conservation measures recently taken this field no longer exists as an entity.

A $6\frac{1}{2}$ acre plot at Shika grown by the Grassland Officer, gave 579 lb. of seed-cotton per acre.

At Daudawa seed from the Samaru 1954-55 crop of Samaru 26J and its component substrains was successfully made to cover in all over 320 acres—all the area allocated for cotton except the Tractor Unit Farm.

Two "Stage B" areas of a nominal 20 acres each were planted, one with 479-25 B.C.P. and one with 479-25-97. The remaining 280 acres constituted a "Stage C" (little short of the nominal 300 acres for this stage) of "First Wave 26J". This was sown with mixed seed of 479-25 B.C.P., 479-25-44 and 479-25-97 in the ratio of 60:20:20.

This attempt to build up the seed of this new strain at an accelerated pace was successful. Yields were good and, with the help of contributions from plots at Samaru and Shika, approximately 39 tons of First Wave Samaru 26J were produced for issue to the cultivators growing Stage D in 1956-57.

The yields per acre 590 and 570 lb. of seed-cotton for the two stage B areas and 408 lb. over the Stage C area are noteworthy in view of the difficult season and reflect credit on the departmental staff at Daudawa. They also indicate that Samaru 26J can reproduce under large scale cultivation its promising behaviour displayed in small scale tests.

The bulk seed multiplication scheme at Gombe in Bauchi Province was again very successful. Sixty tons of pure stock 26C seed from Daudawa Stage D were multiplied up to give more than 470 tons of seed suitable for issue to the remainder of Gombe division. The proportion of grade 3 produce (not acceptable for seed) was this season below 10 per cent of the total crop—a big improvement on previous seasons.

BACTERIAL BLIGHT (*XANTHOMONAS MALVACEARUM*)

Pending the establishment of a programme of pathological work on cotton under a trained plant pathologist some field experiments concerned with the control of bacterial blight were continued by cotton breeding staff. Trials of a needle prick technique for stem inoculation as a test of resistance in breeding work were repeated, but for the second season no really satisfactory results were obtained.

A trial of seed dressed with the mercurial disinfectant Agrosan G.N. 5 in comparison with undressed seed was repeated with large plots separated, this season, by 10 yard screens of guineacorn.

The behaviour of the disease as judged by counts of plants showing symptoms, followed the course of previous seasons. A striking difference between the two treatments early in the season gradually became obscured by what appeared to be secondary spread (*see* Table 75). By picking time there was little visual evidence that the plants from dressed seed were in any way more free from symptoms or likely to yield more cotton. The first picking

moreover did not suggest any yield difference would be established and maintained in the final yields. The experiment was deliberately sited on weed-infested land subject to severe waterlogging, and plot to plot variation within treatments was very great.

The collection of yield data from the guineacorn screens, however, enabled some adjustment to be made for this variability by a covariance analysis. The final seed-cotton yields with and without this adjustment are given in Table 75.

From these figures it appears that the protection given to the plants by dressing the seed was sufficient to be reflected in the yields. The seed used was taken from the produce of the plots grown from undressed seed in the previous season's experiment and hence was known to be from plants which had shown considerable infection during their growth. It was lightly delinted (once through the machine) prior to dressing with Agrosan G.N. 5 at the rate of 1:150 by weight.

Both 26C and 26J were included in the experiment. No difference in their response to seed dressing could be detected. The relative yields of the two strains are more in keeping with expectation after adjustment; a point which perhaps encourages the acceptance of the adjusted figures for the dressed versus undressed comparison as the more correct. The difference between the two strains in seed-cotton yields is quite insignificant. The difference between Undressed and Dressed means is not statistically significant but is suggestive of an effect.

TABLE 75.—SEED DISINFECTION TRIAL. COUNTS OF INFECTED PLANTS AND ADJUSTED SEED-COTTON YIELDS OF PLOTS GROWN FROM UNDRESSED (U) AND AGROSAN DRESSED (D) SEED

	26C			26J			Mean of Two Strains	
	U	D	Mean	U	D	Mean	U	D
<i>Counts of Infected Plants</i>								
At 25 days	539	0	—	632	1	—	586	1
At 35 days	721	4	—	762	7	—	742	6
At 52 days from planting ...	751	59	—	765	74	—	758	67
<i>Seed-Cotton Yields (lbs. per acre)</i>								
First picking alone (Crude) ...	52	59	56	49	46	48	50	52
All picking (Crude)	384	407	395	350	376	363	367	392
							(100)	(106.8)
All pickings (Adjusted) ...	347	397	372	355	417	386	352	407
			(100)			(103.8)	(100)	(115.6)

AGRONOMIC EXPERIMENTS

A number of experiments concerned with cultural practices, manuring, etc., carried out at Samaru and elsewhere, largely under the control of the

Agronomist and in co-operation with the Chemist, have cotton as the test crop. Some of the results from seven of these are briefly presented and discussed below.

The results are grouped to enable conclusions to be drawn concerning the overall effects of the various factors under trial: the full results experiment by experiment are too voluminous for inclusion here.

Planting Date.—Tables 76 and 77 present the results of trials of planting at various dates between 16th June and 3rd of August. Plantings later than this latter date are no longer being tested as past results have given more than adequate evidence that late August or September plantings give greatly inferior yields.

This season's results show very clearly that early July (the recommended time) was in fact the best time to plant; the rather unusual season has not proved exceptional in this respect.

Out of the eighteen sets of figures presented in the two tables there is only one case where June planting appears substantially superior to early July (Daudawa with nitrogenous manuring alone Table 77). This result is not statistically significant and is contradicted by the result given by no fertiliser and by nitrogen plus phosphate at the same site.

TABLE 76.—PLANTING DATES OF COTTON AT VARIOUS LOCALITIES
AND LEVELS OF FERTILITY
(Pounds of Seed-Cotton per acre)

	19th June	3rd July	17th July	31st July	S.E.
Samaru High	642 (100)	641 (100)	336 (52)	273 (43)	±38.5 (6.0)
Samaru Low	446 (96)	465 (100)	257 (55)	213 (46)	±38.5 (8.3)
Daudawa High	639 (95)	670 (100)	640 (96)	523 (78)	±45.7 (6.8)
Daudawa Low	553 (92)	604 (100)	584 (97)	433 (72)	±45.7 (7.6)
Kontagora S High	565 (103)	450 (100)	404 (90)	284 (63)	±52.3 (11.6)
Kontagora S Low	363 (97)	376 (100)	241 (64)	280 (74)	±52.3 (13.9)
Kontagora U	58 (104)	56 (100)	73 (130)	58 (104)	±7.4 (13.2)
Gombe	414 (94)	442 (100)	469 (106)	273 (62)	±52.1 (11.8)

“High” indicates higher level of fertility (natural or induced by manuring with F.Y.M.)

“Low” indicates lower level of fertility.

“Kontagora S” indicates experiment sprayed with insecticide.

“U” indicates unsprayed.

TABLE 77.—PLANTING DATES OF COTTON WITH AND WITHOUT APPLICATIONS OF NITROGENOUS AND PHOSPHATIC FERTILIZERS

(Pounds of Seed-Cotton per acre)

Site		Fertilizer	16th June	8th July	3rd August
Samaru	...	None	355 (82)	433 (100)	226 (52)
		Nitrogen	420 (80)	525 (100)	268 (51)
		Phosphate	414 (70)	593 (100)	286 (48)
		N plus P	569 (80)	708 (100)	371 (52)
Daudawa	...	None	369 (80)	464 (100)	194 (42)
		N	583 (128)	454 (100)	243 (54)
		P	436 (76)	570 (100)	230 (40)
		N+P	544 (63)	681 (100)	202 (30)

The drop in yield shown by the last planting date, at Samaru in both tables and at Daudawa in Table 77, is in keeping with that generally occurring in normal seasons. The drop at the other stations listed in Table 76, is less than usual but is still very substantial in all cases except Kontagora unsprayed. This experiment gave *extremely* low yields at *all* dates.

The failure of the first and second plantings at Gombe to out-yield the third can be attributed to poor erratic germination of the early plantings during a quite unusual dry spell. Even under such conditions however, there was no very great gain from delaying the planting till mid July.

It is clear from Table 76 that the choice of fertile land or the use of F.Y.M. does not reduce the desirability of getting the crop in during early July. The *relative* yields from the various plantings are in general quite unaffected by the fertility level. This is true also for the use of fertilisers; they have had no substantial effect on the planting date differences (with the single doubtful exception mentioned above).

Fertilisers.—Table 78 gives the results of applying sulphate of ammonia and superphosphate, each alone and the two together, in experiments at Samaru and Daudawa.

The yields given by three separate planting dates have been combined in forming this table but separate figures are presented for the results obtained by applying the fertilisers at different stages in the growth of the crop. The responses which might have been obtained by applying nitrogen at one stage and phosphate at another were not tested; where N and P were applied, they were applied together.

In contrast with last season, a marked response was obtained with applications of nitrogen. The responses to N and P were additive. Although the different times of application did not give results differing statistically, a general trend in favour of the earliest possible application is apparent from the figures.

TABLE 78.—NITROGEN AND PHOSPHATE APPLIED TO COTTON
SEPARATELY AND IN COMBINATION
(Pounds of Seed-Cotton per acre)

	None	N alone	P alone	N+P	S.E.
<i>Samaru</i>	%	%	%	%	%
Kind of fertiliser	338(100)	405(120)	431(128)	549(162)	±15.6(4.6)
Different (a) ...	—	450(133)	459(136)	579(171)	
Times of (b) ...	—	406(120)	430(127)	563(167)	±27.0(8.0)
Application (c) ...	—	358(106)	404(120)	506(150)	
<i>Daudawa</i>					
Kind of fertiliser	342(100)	427(125)	412(120)	476(139)	±25.5(7.5)
Different (a) ...	—	445(125)	438(128)	505(148)	
Times of (b) ...	—	395(115)	416(122)	476(139)	±44.2(12.9)
Application (c) ...		440(129)	381(111)	446(130)	

(a) Fertiliser applied at planting time.

(b) Fertiliser applied at thinning time (approx. 4 weeks)

(c) Fertiliser applied at flowering time (approx. 10 weeks from planting).

Response to Fertiliser significant at each site.

Time of application not significant at either.

Seed Preparation.—Cotton seed in Nigeria is normally planted just as it comes from the saw gins, i.e., with the greater part of the lint removed but still carrying a heavy coat of “fuzz” or “linters”. Seed with this fuzz partially or totally removed is more easily handled and germinates more rapidly and uniformly.

Results of two replicated trials comparing “raw” with machine delinted and with acid treated seed are given in Table 79. Machine delinting removes the greater part but not the whole of the fuzz reducing the weight of the raw seed by about 7 per cent. Treating with concentrated sulphuric acid removes all the fuzz and reduces the weight by approximately 11 per cent.

The results suggest that the removal of the fuzz coating can produce a small but appreciable yield increase—far more than sufficient to cover the cost of the process apart from the saving in costs of handling and transport and economy of seed in planting. The more practicable process—delinting by machine—is however disappointing in comparison with the use of corrosive acid. Previous results in Northern Nigeria have shown that even acid treating does not always result in a measurable response. This season’s results have been in part due to the difficult growing conditions. The experiment is being repeated.

TABLE 79.—COMPARATIVE YIELDS USING SEED WITH AND WITHOUT
THE REMOVAL OF "FUZZ" BY DELINTING
(*lb. of seed cotton per acre in two experiments*)

	<i>Samaru</i>	<i>Daudawa</i>	<i>Combined Result</i>
"Raw" Seed			
(Fuzz not removed)	398	561	480 (100%)
Machine Delinted Seed			
(Fuzz partially removed) ...	405	580	493 (102.7)
Acid Treated Seed			
(Fuzz totally removed) ...	424	602	513 (106.9)
Standard Error	± 14.0	± 25.1	± 14.4 (3.0)

Neither of the separate experiments nor the combined result is statistically significant but the combined result is suggestive of a real effect.

Spacing.—The conclusions to be drawn from the consistent results obtained from a series of spacing experiments at Samaru and Daudawa in previous seasons have been presented in last season's report. Similar experiments at Kontagora last season gave discordant results and further trials were therefore carried out at that station alone in the current season.

The results are presented elsewhere (p. 94 Table 83 under Cotton Entomology). These do not support the tentative conclusion drawn last season that close spacing results in substantially higher yields at this station. Further examination of last season's results has indeed shown the analysis to be faulty and the conclusions invalid.

IV. COTTON ENTOMOLOGY

BY M.A. CHOYCE AND M.G. EMSLEY.

INTRODUCTION (M.A.C.)

Entomological records were obtained this year from Samaru (Zaria Province), Gombe (Bauchi Province), Kontagora and Mokwa (Niger Province) and from Shendam (Plateau Province) up to the end of October. Observations at these stations indicate that insect pests were generally rather more abundant than during last season, being similar to the level of infestation during 1953-54.

Work on the Red Bollworm has again shown that emergence from long-term pupae may be more or less continuous from June until November.

Pink Bollworm was slightly more abundant than last year, and greater efforts have been made to impress upon all farmers the importance of the Close Season, particularly in Katsina Province,

At Mokwa there was a close relationship between the incidence of Cotton Stainers in the crop and the shedding of green bolls. It seems fairly certain that low yields on the Agricultural Project at this station were largely due to this pest.

Flower tagging experiments at all stations have yielded valuable data on crop development and pest attack.

Increases in yield following application of insecticides to cotton at Samaru were probably related to the difficult growing conditions. Losses due to insect pests are given as 43 per cent of potential yield in one experiment, compared with a provisional figure of 25 per cent estimated last season. At Kontagora a repeatedly sprayed Date of Sowing, Spacing and Manurial trial yielded just over 500 per cent more than a similar unsprayed trial.

There is as yet little possibility of using insecticides on a commercial scale in the main cotton growing areas. Trials in the principal Riverain provinces, where pests are more numerous, are yielding more promising results, and these are being extended.

At Samaru the pattern of work is changing, and more emphasis is being given to biological studies of crop pests, and estimations of losses due to them. This work is essential to a thorough understanding of the problems, and may lead to more practical methods of pest control.

OBSERVATIONS ON COTTON PESTS. (M.G.E).

Diparopsis watersi (Roths).—The Red Bollworm.—There is considerable local variation in population density; during the course of a tour in late November 1955 several small apparently isolated pockets of high intensity were discovered in areas of an otherwise low level.

Three years' observations at Gombe and Kontagora have shown that populations gradually build up from the end of September, rising to a peak of varying prominence at the end of November and declining to the beginning of January. The duration of substantial infestation is longer at Kontagora in harmony with the longer growing period. District variation in populations is shown in Table 81, but these figures obtained from single observation plots are not necessarily typical of the whole.

Continued experiments on the life history have reinforced the conclusion of last year that emergence of moths from pupae diapausing over the dry season may be continuous from early June until the end of November. Figure 3 should be compared with Figure 1 of the Annual Report, 1954-55. Results from Kontagora have been disappointing for the past few years, mortality reaching this year 86 per cent. At Samaru mortality was 97 per cent though it was the first year the pupae had been left undisturbed in the soil and not sieved and re-placed as in previous seasons (see Geering, Q.A. And Baillie, A.F.H. Bull. Ent. Res. 45, pt 4, 1954).

It is interesting to note that at Gombe, no parasites were recorded from 378 pupae and last year only 1.3 per cent were parasitised, whereas elsewhere parasitism by the fly *Carcelia* sp. (Diptera: Tachinidae) may reach around 20 per cent.

As in previous years the period during which 50 per cent of the pupae diapause and 50 per cent do not, was in the first week of November. Before this date all the pupae emerge in about three weeks, after this date all the pupae diapause over the dry season to emerge between June and November the following year. The 50 per cent: 50 per cent period appears quite constant for all seasons in all localities to within a few days of the first week of November. There is at this time a rapid drop in relative humidity but this correlation has not been examined statistically and the evidence is only circumstantial.

Platyedra gossypiella Saund.—The Pink Bollworm.—Pink Bollworm is not normally considered a serious pest of cotton in Northern Nigeria but following a case of intense infestation in the Yashi District of Eastern Katsina a brief survey was undertaken embracing Katsina Province and Eastern Sokoto. Examination of ginnery samples and seed cotton in the official markets showed that infestation generally was only slightly above a normal year. It is now thought that this one instance was an isolated example of perhaps fadama grown cotton left standing over from the previous season. It serves as a warning against inadequate enforcement of the close season: a greater effort has been made this year to ensure that the measures have been carried out.

Market samples, supplied from the ginneries, have been examined continuously throughout the harvest season. A summary of the data appears in Table 80, and it closely approximates to last year's result.

Experiments on larval emergence were ruined by predacious mites killing all the larvae between the end of March and the beginning of April.

TABLE 80.—LARVAE FOUND IN SEED COTTON SAMPLES FROM COTTON MARKETS

N.A. Grade	No. of 1 lb Samples	Larvae inside seed		Larvae outside seed		Totals			
		Living	Dead	Living	Dead	Living	Dead	L and D	
I ...	55	31	46	1	20	32	66	98	
II ...	55	34	76	4	33	38	109	147	
III ...	49	36	91	7	28	43	119	162	
Total ...	159	101	213	12	81	113	294	407	
Number of larvae per 10 lb sample 1955-56				...	...	...	7.1	18.4	25.4
Number of larvae per 10 lb sample 1954-55				...	...	...	9.0	16.1	25.1

Other Bollworms.—Normally *Diparopsis* is considered the main pest of cotton in Northern Region, but there is evidence that suggests in areas away from Samaru other bollworms are more important than has been previously thought, particularly at Shendam and Mokwa, (see Table 81). New techniques for obtaining data on pest distribution should yield more accurate information. But it is almost certain that some entomological assistants will continue to confuse the identification of *Platyedra* and *Argyroprocto*, whose larval and pupal forms are extremely difficult to distinguish in the field.

When considering the figures appearing in Table 81, it must be remembered that they have been obtained from one particular plot at each district; variation in infestation may be considerable even from field to field, but the observation plots are grown under normal cultural conditions.

Both *Platyedra* (Pink Bollworm) and *Earias* spp. (Spiny bollworm) appear in the crop after mid-November at which time *Diparopsis* is on the decline, but they may persist until harvest. Consequently though at any one time their numbers are inferior to those of *Diparopsis*, the duration of the attack considerably increases the amount of damage they can do.

TABLE 81.—SUM TOTALS OF BOLLWORM LARVAE COLLECTED FROM FORTNIGHTLY SAMPLES THROUGHOUT THE SEASON FROM EARLY SEPTEMBER ONWARDS

Station	Red Bollworm	Spiny Bollworm	Pink Bollworm	American Bollworm	False Codling Moth	Unknown
Samaru ...	126	17	2	—	2	—
Gombe ...	145	55	43	2	—	—
Kontagora ...	306	269	195	5	30	3
Mokwa ...	10	93	93	4	1	—
Shendam ...	7	56	175	14	6	—
Total ...	594	490	508	25	39	3

The figures in Table 81 are comparable for Samaru, Kontagora and Gombe, but at Shendam observations were discontinued on 25-10-55, so the figures are all far short of the potential total, and at Mokwa the unusual local spacing of 3ft. x 3ft. makes comparison difficult with other stations where the recommended 3ft. x 18ins. is carried out. However in all cases the figures are from a series of similar strips, each of 170 stands, one strip being examined each fortnight.

Dysdercus spp.—The Cotton Stainers.—The following remarks apply almost exclusively to *Dysdercus supersticiosus*; (F) for it is by far the most common species; only *D. fasciatus* Sign. has been seen in addition and then in much smaller numbers.

At Mokwa this year the bulk of the crop was lost by the excessive shedding of green bolls during the period of maximum flowering in mid-October (*see* Figure 4). It is well known that such shedding can take place in the absence of insects for physiological reasons, but the coincidence of the immigration of adult stainers and the immediate increase in shedding is remarkable. Figure 4 shows the estimated stainer population and shed bolls from 2,237 carefully tagged flowers on 100 plants.

It has been calculated from the tagging data that shedding most commonly takes place from between 3 to 7 days after flowering, (*see* Figure 4), and the time difference between the population and shedding curves is initially of this order. There is more than a suggestion that stainers have induced the excessive shedding: this is not a new idea but hitherto substantial evidence has been lacking from this area.

A somewhat similar situation appears at Gombe, (*see* Figure 5) but obviously after the initial burst of shedding some other factor has operated to produce a further acceleration in rate of shedding, it may be due perhaps to some other sap-sucking insect (Hemiptera) not normally sampled, for example a Mirid.

At Samaru the stainer level was so low that no correlation with shedding could be made.

For a number of years records of stainers on cotton and on alternative host trees have been made. Thorough examination of the gross data is not complete but the general conception is clear. The time during which cotton can support a breeding population with an occasional temporary immigration in August that rarely persists, due possibly to the immaturity of the plants. By mid-December all stainers have left the crop but their destination is not known.

Certain trees upon which stainers are suspected of feeding and breeding have been examined continually for a number of years now and though the quantitative data are unreliable the presence or absence of stainers and at what stage of development is most important. A brief summary of the data appears in Figure 6 showing that even though these trees do harbour large populations for a greater part of the year the location of the insects in January and early February is unknown. It would be at this time that their populations are at their lowest ebb and would be the most opportune moment for implementing control measures if possible. At this time a few adult stainers have been found in refuse, vegetable rubbish and at the roots of herbs but this may not be the normal habitat. That adults only are recorded in February and March strongly suggests that they pass the dry season as adults. But they certainly breed rapidly on Kapok (*Bombax buonopozense*) in March and April.

There is little doubt that a large reserve of insects are carried by the Baobab (*Adansonia digitata*) and it is from these that a large part of the

invasion into the cotton fields takes place. Whatever species of plant the stainers attack they seem to feed almost exclusively on the ripening or over ripe fruits.

Mirids (Hemiptera: Heteroptera: Miridae).—Plant Bugs.—The biology of the Miridae is the main item on the programme of biological research next season, preliminary collections and observations have been made and the following genera have been identified by the British Museum (Natural History), London: *Lygus vosseleri* Popp., *Megacoelum* sp., *Eurystylus* sp., *Stenotus* sp., and *Campylomma* spp.

Lygus, *Stenotus* and *Campylomma* have been observed, microscopically, to feed on living *Gossypium* tissue.

Tattering, attributed to mirids, was again severe this year, though locally very variable.

Crop Development Studies.—Flower tagging has been carried out at Kontagora, Mokwa, Gombe and Samaru. Observations at Shendam were discontinued in October. At each locality 10 randomly disposed strips are allocated at planting, each strip containing 100 plants, and all the flowers are tagged as they open and their subsequent fate recorded in a ledger. This provides a wealth of fundamental data from which only extracts can appear here; it is hoped to publish full details elsewhere.

Figure 7 shows frequency distribution histograms of days that elapse from flower opening to boll shedding, these show that the majority of shed bolls shed within a week of flowering.

Figure 8 shows in histogram form the numbers of flowers that open each week and the proportion of these that ultimately become a pickable harvest. It will be seen that the peak of flowering does not always provide the bulk of the harvest, in fact at Mokwa about half the harvest came from the tail-end of the season because the bulk of the crop was lost through excessive shedding in October.

The main shortcoming of this method is that with the assistants available, it is impossible to study bud initiation. It is believed that many phytophagous insects have a partiality for buds as also have sap-sucking insects, in which case the flowering curves obtained may differ markedly from the potential flowering in the absence of insect pests.

Owing to the variation from plot to plot and from season to season, it is unwise to draw conclusions at this stage but after data from a number of sites and years have been collected the insight into plant behaviour should throw new light onto our entomological problems.

INSECTICIDE TRIALS. (M.A.C.)

Samaru.—(a) In the Annual Report for 1954-55 it was suggested that damage by pests to bolls retained on the plant reduced yield by about

25 per cent. This was assumed to be the greater part of the total loss in yield in seasons when shedding induced by insects was to a large extent compensated for by the plant, as shown by absence of significant increases in yield following application of insecticides designed chiefly to reduce shedding.

In seasons when pest incidence is high, or when there is a moderate pest attack on cotton which has low compensatory powers, insect-induced shedding will cause additional crop losses. In these cases it might be possible, with insecticides, to reduce pest incidence to a level at which physiological shedding is dominant, without the necessity for complete control of pests concerned. Suitable observations on the crop would then enable a reasonable estimation of losses due to insect pests to be made.

A preliminary trial to test this assumption was laid down at Samaru on cotton sown on 25th June in plots of 390 square yards, with discards 5 yards wide between and surrounding all plots. There were six replications of the following treatments:—

A—DDT/BHC spray: 2 lb. DDT 0.6 lb; gamma BHC/acre

B—Dieldrin spray: 0.47 lb. Dieldrin/acre.

C—Control.

The sprays were applied on 5th October, 19th October, 2nd November and 15th November at a rate of approximately 25 gallons per acre, using knapsack sprayers.

Picking began at the end of November and continued until the third week of January. Final yields of unsorted seed cotton were:

	<i>Per cent</i>				
A—564 lb./acre	...	...	...	...	150**
B—489 lb./acre	...	...	...	...	130*
C—377 lb./acre	...	...	...	...	100
S.E. $\pm$ 32	...	...	...	...	8.5
Coeff. of Variation:	...	...	...	...	16.3

Basing calculations on the yield of treatment A, and making allowance for loss in weight of damaged seed cotton, the possible yield in the absence of pests under the conditions of the experiment would have been 665 lb. seed cotton per acre. As the control plots yielded 377 lbs. per acre, loss due to pests was 43 per cent. Additional observations show that of this loss 34 per cent could be attributed to shedding and 9 per cent to damage to split bolls.

The significant increase following the use of insecticides on cotton at Samaru this season is probably related to the difficult growing conditions. In another experiment application of DDT/BHC spray (3 lb. DDT and 1 lb. gamma BHC per acre) on 29th September, 13th October, 27th October and 10th November increased yields by 56 per cent:

Mean yield of 8 sprayed plots: 583 lb. seed cotton/acre.

Mean yield of 24 untreated plots: 374 lb. seed cotton/acre.

(b) A replicated trial to test the effect of alpha-naphthalacetic acid and 2,4D on yield of seed cotton was carried out on cotton sown on 5th July. Plot size was 4 ridges x 12 yards, the two middle ridges being treated.

Results were as follows:—

- (i) Application of alpha-naphthalacetic acid in solution containing 10 p.p.m. at rate of 1 gallon to 24 square yards on 23rd September, 29th September, 14th October, 29th October and 10th November did not lead to any increase in yield compared with untreated cotton:

Mean yield of 16 treated plots: 369 lb. seed cotton/acre

Mean yield of 24 control plots: 374 lb. seed cotton/acre

- (ii) Application of 2,4D in solution containing 5 p.p.m. active ingredient at rate of 1 gallon to 24 square yards on 22nd September, 29th September, 14th October, 29th October, and 10th November produced typical damage to the plants which were almost killed. The yield was reduced to 53 lb. seed cotton per acre. (14 per cent of control plots).

(c) The results of a trial using gamma BHC alone and in combination with Agrosan GN5 as a seed dressing, are shown in Table 82. There were six replications of twelve treatments on plots of 4 ridges x 12 yards. The seed used was raw 26C, which was sown on 7th July on a site that had lain fallow for some years. Superphosphate, at 44 lb. per acre, was applied on 22nd July. Agrocide 15W was used as the source of gamma BHC.

At the rates used, BHC did not prevent development of bacterial blight in early stages of growth; this disease was controlled by Agrosan GN5 up to late August, after which there was a general spread throughout all plots. The final overall yield on the trial was low and treatment differences were not significant.

There is a suggestion that some of the treatments have reduced the number of plants with distorted roots. This distortion was noticed during the course of uprooting at the end of last season; in extreme cases there was excessive bifurcation and contortion of the taproot. Subsequently the roots of the Samaru Date of Sowing, Spacing and Manurial Trial were examined; though there was much variation within blocks and treatments, no regular pattern of variation was obvious. This phenomenon is apparently similar to that reported from North Carolina, with an equally vague origin. (Moore, R.P.—“The Case of the Missing Taproot”. *Crops and Soils*, 1956, 8 No. 4. p.19).

Kontagora.—Last year's experiment in which a complete Date of Sowing, Spacing and Manurial Trial of Cotton was regularly sprayed during the season, for comparison with an unsprayed trial, was repeated.

The dates of sowing this year were 19th June, 3rd July, 17th July and 31st July.

Spray (2 lbs. DDT and 0.6 gamma BHC/acre) was applied at fortnightly intervals. 9 applications, beginning on 10th August were made on 19th June sowing. Number of sprays were reduced on later sowings, that of 31st July receiving 6 applications beginning from 21st September.

A summary of results is shown in Table 83. The sprayed trial showed an overall increase in yield of just over 500 per cent of the yield of the unsprayed trial. In neither trial is there any significant difference in the yields from different spacings.

TABLE.—COTTON SEED TREATMENT TRIAL, USING GAMMA BHC AND AGROSAN GN5:
SUMMARY OF RESULTS

Seed Treatment	Gamma BHC W/W		Agrosan GN 5 W/W		1:1000 Nil	1:2000 Nil	1:4000 Nil	1:1000 1:1500	1:2000 1:150	1:4000 1:150	1:1000 1:300	1:2000 1:300	1:4000 1:300	Nil 1:150	Nil 1:300	Nil Nil
	1:1000 Nil	1:2000 Nil	1:4000 Nil	1:1000 1:1500	1:2000 1:150	1:4000 1:150	1:1000 1:300	1:2000 1:300	1:4000 1:300	Nil 1:150	Nil 1:300	Nil Nil	Nil Nil	Nil 1:150	Nil 1:300	Nil Nil
Percentage Stands Germinated on 14th July	93.7	94.6	93.8	93.8	87.1	90.0	91.7	91.7	96.2	91.7	93.3	90.8	90.8	91.7	93.3	90.8
Percentage Stands Germinated on 22nd July... ..	66.0	63.1	62.6	67.0	66.7	66.3	67.7	67.1	71.0	69.0	69.8	62.2	62.2	69.0	69.8	62.2
Mean Plant Height in Inches on 10th August	5.3	5.1	5.1	4.6	4.9	5.0	5.1	5.0	5.5	5.1	5.3	5.0	5.0	5.1	5.3	5.0
Mean Plant Height in Inches on 26th August	6.7	6.8	6.9	6.3	6.5	6.4	6.5	6.5	6.9	6.5	7.0	6.4	6.4	6.5	7.0	6.4
Percentage of Stands with active Bacterial Blight { on 16th August on 31st August on 19th Sept.	3.1 10.1 22.2	3.7 7.6 23.4	7.7 23.4 24.2	0.0 1.1 15.5	0.0 1.7 12.7	0.0 2.1 17.0	0.0 2.9 15.3	0.0 2.9 15.3	0.2 1.5 17.0	0.0 1.1 7.4	0.0 1.8 8.4	4.3 12.1 25.2	4.3 12.1 25.2	0.0 1.8 8.4	0.0 3.6 12.5	4.3 12.1 25.2
Weight (lbs) of 100 seedlings thinned on 11th August ...	0.44	0.40	0.44	0.37	0.39	0.33	0.41	0.39	0.41	0.40	0.41	0.38	0.38	0.40	0.41	0.38
Percentage of Plants with Distorted roots (early December)	9.1	13.1	17.3	9.2	13.0	13.5	15.4	9.8	11.3	6.6	18.25	23.4	23.4	6.6	18.25	23.4
Yields—lbs. seed-cotton per acre	272	214	283	273	301	282	281	297	294	273	259	285	285	273	259	285
Difference from Control	-13	-71	-2	-12	+16	-3	-4	+12	+9	-12	-26	-	-	-12	-26	-

TABLE 83.—SPRAYED AND UNSPRAYED TRIALS OF COTTON AT KONTAGORA AT VARIOUS PLANTING DATES AND SPACING MANURED AND UNMANURED

Yields of Seed Cotton in lb. per acre.

		MANURED				UNMANURED				GRAND MEAN
		9"	18"	27"	MEAN	9"	18"	27"	MEAN	
19th June ...	Sprayed ...	612	553	529	565	343	376	370	363	464
	Unsprayed ...	48	59	48	52	65	65	61	64	58
3rd July ...	Sprayed ...	435	519	396	450	392	322	414	376	413
	Unsprayed ...	41	36	38	38	76	80	62	73	56
17th July ...	Sprayed ...	449	405	358	404	242	252	232	242	323
	Unsprayed ...	64	58	63	62	85	80	88	84	73
31st July ...	Sprayed ...	296	296	271	284	281	274	284	280	282
	Unsprayed ...	53	51	48	51	65	61	70	65	58
MEAN ...	Sprayed ...	446	443	388	426	314	306	325	315	370
	Unsprayed ...	52	51	49	51	73	72	70	72	61

Grain Storage.—The air tight, underground Argentine grain storage tank was refilled with guineacorn in March, 1955 (for first filling refer to Annual Report 1954-55, p. 67, section H(3).

Since then the Chemist has extracted samples of gas from inside the tank every three or four days and estimated the Carbon dioxide concentration.

In temperate climates the Carbon dioxide concentration rises to 3 or 4 per cent in a few days and to 10 per cent in a month or two but reaches 15-20 per cent only after some years. The Samaru tank Carbon dioxide concentration reached 12 per cent in six weeks but instead of continuing to rise at a decelerating rate, fell off suddenly to between 3 and 4 per cent during June and July. Thereafter it did rise slowly and regularly (within the limits of experimental error) and reached 12 per cent again by May 1956.

The suggested reason for this peculiar behaviour is that the heavy storms from May to July 1955 disturbed the newly laid air tight covering layer of the tank and allowed currents of fresh air to circulate through the tank. The succeeding rains and dry season probably enabled the sealing layer to bed down sufficiently well to withstand the relatively meagre storms that we have had this year.

V. CHEMISTRY SECTION

By G. M. Higgins and T. B. Miller

INTRODUCTION (G.M.H.)

As in previous years the main work of the section has been concerned with the design, control and recording of a large number of fertiliser extension experiments designed to ascertain the optimum rates of application of fertilisers to the various crops of the region. With the expansion of the Research Station, however, this work in the future is to be controlled by the Agronomy Section, while the Chemistry Section concentrates more upon other important fertility problems which require urgent investigation in Northern Nigeria. To facilitate continuity with future reports, the present account of the work carried out is divided into two main sections: (a) that concerned with fertiliser extension experiments in future to be controlled by the Agronomy Section, and (b) investigations of fertility problems and normal agricultural chemical investigations which, in the future, will be greatly extended by the Chemistry Section. Routine laboratory investigations are also recorded under this section. Time of Application trials have already been taken over and are reported on by the Agronomy Section.

Fertiliser Extension Experiments.—Trials designed to ascertain the optimum rates of application of nitrogenous and phosphatic fertilisers required to increase yields of the main crops of the region were continued during 1955. As in previous years these experiments were, wherever possible, carried out on Government experimental farms, but in areas not catered for by these stations, were carried out on farmers' own land and under local farming conditions. The success of the latter has now been fully recognised, the original trials in Benue and Plateau Provinces having been extended during the year to include Zaria, Niger and Adamawa Provinces also eight to ten sites are normally originally selected in each area, each site forming a single replication of a 3^2 N and P factorial layout, using nil, $\frac{1}{2}$ cwt. and 1 cwt. of superphosphate and sulphate of ammonia per acre. At each site the farmer is allowed to follow his own system of cultivation. The only operations carried out by the Department being the fertiliser applications and the recording of yields at harvest. It is usually necessary to discard several of the original sites by harvest time, owing to accidents of various kinds, but sufficient remain to give a statistical analysis. The results of both types of experiments are recorded in the present Report under the headings of the various crops, being further subdivided where necessary under provincial headings.

Cotton, Niger Province.—Two trials on cotton were carried out in Niger Province during the year. At Lemu demonstration farm three randomised blocks each of nine plots were used, while at Abuja the trial was carried out on farmers' own farms. In both cases cotton yields were of a very low order and, despite the fact that significant differences were obtained, the results must be considered unreliable and are presented for record purposes only. (Table 84).

TABLE 84.—FERTILISERS ON COTTON, NIGER PROVINCE
lb. Seed-cotton per acre

					Abuja	Lemu
<i>Sulphate of Ammonia</i>					***	N.S.
Nil	(N0)	...	...	...	111	140
56 lb. per acre	(N1)	...	...	...	148	145
112 lb. per acre	(N2)	...	...	...	158	179
<i>Superphosphate</i>					**	*
Nil	(P0)	...	...	...	119	140
56 lb. per acre	(P1)	...	...	...	146	134
112 lb. per acre	(P2)	...	...	...	151	189
S.E.	...	...	...	...	±6	±14
Interaction					**	N.S.

		N0	N1	N2	N0	N1	N2
P0	...	69	128	160	124	114	181
P1	...	118	156	165	111	141	149
P2	...	144	160	148	184	178	207
S.E.	...		±11			±24	

Onions, Zaria Province.—An experiment designed to ascertain the fertiliser requirements of onions was carried out on farmers' own farms at Majeru in Zaria Province. The design of the trail 3² factorial, allowed the comparison of all combinations of three levels of sulphate of ammonia and three levels of superphosphate. No significant differences in yield due to the fertiliser applications were observed, a summary of yields in lbs. of onions per acre being presented in Table 85, where P0, P1 and P2 equal nil, $\frac{1}{2}$ cwt. and 1cwt. of superphosphate, and N0, N1 and N2 equal nil, $\frac{3}{4}$ cwt. and 1 $\frac{1}{2}$ cwt. of sulphate of ammonia per acre.

TABLE 85.—FERTILISER TRIAL ON ONIONS, MAJERU
lb. Onions per acre

				N0	N1	N2	<i>P Means</i>
P0	...	...	...	6,258	6,585	5,983	6,245
P1	...	...	...	5,232	6,461	7,168	6,287
P2	...	...	...	7,461	6,519	6,536	6,839
N Means	...	...	...	6,317	6,522	6,533	

S.E. Main effects = ± 323 ,

S.E. Interaction = ± 559

Tobacco, (a) Zaria Province.—A series of trials carried out on farmers' own farms at Maigana in Zaria Province gave the results presented in Table 86.

TABLE 86.—FERTILISERS ON TOBACCO, MAIGANA
lb. Green leaves per acre

<i>Treatment per acre</i>								<i>Yield***</i>
1.	1 cwt. ammonium sulphate	plus	1 cwt. superphosphate	...				3,821
2.	Treatment plus $\frac{1}{2}$ cwt. potash	...	...	...	...			3,627
3.	1 cwt. ammonium sulphate	plus	$\frac{1}{2}$ cwt. superphosphate	...				3,258
4.	1 cwt. ammonium sulphate	...	...	...	...			2,900
5.	No manure	...	...	...	...	...	...	2,266
S.E.	...	...	...	...	...	...	...	± 270

These results obtained from six randomised blocks each of five plots, indicate an increment of +634 lb. due to the application of 1 cwt. nitrogen with additional increments of +358 and +921 lb. due to the addition of $\frac{1}{2}$ cwt. and 1 cwt. of superphosphate per acre respectively. The addition of $\frac{1}{2}$ cwt. of potash in the sulphate of ammonia and superphosphate mixture per acre appears to exert a depressing effect of —194 lb.

(b) *Kware, Sokoto Province*.—A similar series of trials carried out at Shinkafe in Sokoto Province failed completely, and no results are available.

RICE

Three fertiliser trials on rice were carried out in the Region during the year, and as the design of each varies they are reported separately under the province where sited.

(a) *Sokoto Province*.—Originally designed to ascertain the optimum rates of nitrogenous, phosphatic and potassic fertilisers required to increase the yield of rice, this trial has now become a variant of the permanent series of D.N.P.K. trials (*see Agronomy Section Report*), treatments being applied to the same plots annually. The design of the experiment, thirty-three factorial with three replications, allows the comparison of all combination of the three levels of each fertiliser, and a summary of the results is presented in Table 87.

TABLE 87.—FERTILISER TRIAL ON RICE, KWARE

lb. paddy per acre

<i>Sulphate of Ammonia:</i>								*
Nil ...	...	...	...	...	...	...	(N0)	1,051
100 lb./acre	...	...	...	...	...	...	(N1)	1,239
200 lb./acre	...	...	...	...	...	...	(N2)	1,397
<i>Superphosphate:</i>								***
Nil ...	...	...	...	...	...	...	(P0)	796
100 lb./acre	...	...	...	...	...	...	(P1)	1,389
200 lb./acre	...	...	...	...	...	...	(P2)	1,501
<i>Muriate of Potash</i>								N.S.
Nil ...	...	...	...	...	...	...	(K0)	1,144
84 lb./acre	...	...	...	...	...	...	(K1)	1,329
168 lb./acre	...	...	...	...	...	...	(K2)	1,214
S.E. ...	...	...	...	...	...	...	...	±83

The results show significant increases in yield due to applications of both nitrogenous and phosphatic fertilisers, the latter being of a very high order, the 1 cwt and 2 cwt per acre dressings of superphosphate producing increments of 593 (74.5%) and 705 (88.6%) lbs of paddy per acre over no phosphate.

(b) *Bauchi Province*.—Designed to ascertain the response of rice to fertilisers under farmers' normal methods of cultivation, this trial consisted of six randomised blocks each of twelve plots, comparing all combinations of three levels of sulphate of ammonia and four levels of superphosphate. The results of (Table 88) were disappointing, no significant differences being obtained even with the higher levels of application.

TABLE 88.—FERTILISER TRIAL ON RICE, BAUCHI

<i>lb. paddy per acre</i>				
<i>Sulphate of Ammonia</i>	<i>Nil</i>	<i>56 lb.</i>	<i>112 lb.</i>	<i>P Means</i>
<i>Superphosphate Nil</i>	1,185	1,001	1,352	1,180
56 lb./acre ...	1,102	1,419	1,277	1,266
112 lb./acre ...	1,135	1,268	1,118	1,174
168 lb./acre ...	1,118	1,235	1,293	1,293
N Means ...	1,135	1,231	1,260	
S.E. (P)=±74	S.E. (N)=±64	S.E. (N×P)=±128		

(c) *Badeggi, Niger Province.*—In direct contrast to the lack of response to fertilisers at Bauchi, the trial carried out for us by the Federal Rice Research Unit at Badeggi indicated increments of more than twice the yields obtained from the nil treatment. This trial (42 factorial) consisted of eight blocks, each of eight treatments comparing all combinations of four levels of sulphate of ammonia and superphosphate (Table 89).

TABLE 89.—RICE FERTILISER TRIAL, BADEGGI

<i>lb. paddy per acre</i>									
<i>Sulphate of Ammonia</i>								***	
Nil ...	...	...	...	...	...	...	(N0)	1,343	
56 lb./acre ...	...	...	...	...	...	...	(N1)	2,068	
112 lb./acre ...	...	...	...	...	...	...	(N2)	2,404	
168 lb./acre ...	...	...	...	...	...	...	(N3)	2,569	
<i>Superphosphate</i>									
Nil ...	...	...	...	...	...	...	(P0)	1,821	
56 lb./acre ...	...	...	...	...	...	...	(P1)	2,096	
112 lb./acre ...	...	...	...	...	...	...	(P2)	2,194	
168 lb./acre ...	...	...	...	...	...	...	(P3)	2,273	
S.E.	...	...	...	...	...	...		±52	
<i>Interaction N+P ***</i>						P0	P1	P2	P3
N0 ...	...	...	...	...	...	724	1,204	1,567	1,875
N1 ...	...	...	...	...	...	1,878	2,092	2,288	2,014
N2 ...	...	...	...	...	...	2,174	2,530	2,373	2,539
N3 ...	...	...	...	...	...	2,507	2,558	2,548	2,664
S.E.	...	...	...	...	...	±103			

The yields show highly significant increases both to sulphate of ammonia and to superphosphate.

Owing to partial confounding of different components, it is not strictly possible to present the NxP interaction in a two-way table. The figures shown have ignored the partial confounding, and must be treated with caution. However, the main response is to Nitrogen, and this is more or less linear irrespective of the presence or absence of Phosphorous. Response to phosphate is more or less linear throughout when N is absent, it is linear only to the P2 level when N1 is present, it ceases at P1 when N2 is present and it is not visible at all in the presence of N4. This suggests that the super-phosphate is supplying some need other than phosphorous, which can equally well be provided by Sulphate of Ammonia when the latter is supplied in sufficient quantities. The most obvious possibility is a sulphur deficiency, which has previously been found (though not in rice trials) in this part of Niger Province.

The response to N3 with no superphosphate was a very paying one in this trial. $1\frac{1}{2}$ cwt. per acre of Sulphate of Ammonia, costing 37s-6d, produced an increment of 1,783 lb paddy or approximately 1,300 lb hulled rice. At the ruling price of £50 per ton, this increment was worth approximately £30 per acre.

SOYA BEANS

Niger Province.—The increased production of soya beans in the Kontagora area of Niger Province during the last few years resulted in the carrying out of a trial in 1954 designed to ascertain the crop's fertiliser requirement. The design of the experiment allowed the comparison of two levels of sulphate of ammonia and three levels of superphosphate in all combinations and final yield figures indicated a highly significant response to superphosphate and a small but non significant response to nitrogen. The experiment was repeated in 1955 using increased levels of phosphate and a summary of the two years' results is presented in Table 90.

TABLE 90.—FERTILISER TRIAL ON SOYA BEANS, KONTAGORA
lb. threshed seed per acre

<i>Treatment</i>	1954	1955
Sulphate of Ammonia	N.S.	N.S.
Nil	677	642
56 lb. per acre	703	659
S.E.	±22	±20
Superphosphate	***	***
Nil	530	318
56 lb. per acre	683	—
112 lb. per acre	854	715
168 lb. per acre	—	740
224 lb. per acre	—	830
S.E.	±27	±28

The increase of 512 lbs of seed per acre 161 per cent over nil due to the application of 2 cwts. of superphosphate per acre indicates the very great need for phosphate in the soils of this area.

A slightly modified design of the above layout was employed in the fertiliser trial at Abuja, carried out on Farmers' own farms; three levels of sulphate of ammonia and three levels of superphosphate being tested in all combinations.

The results presented in Table 91 again indicate a highly significant response to superphosphate applications and a small but no significant response to sulphate of ammonia.

TABLE 91.—FERTILISERS ON SOYA BEANS FARMER'S PLOTS, ABUJA
lb. threshed seed per acre

<i>Sulphate of Ammonia at</i>	<i>Nil (N0)</i>	<i>56 lbs/acre (N1)</i>	<i>112 lbs/acre (N2)</i>	<i>Effect ***P</i>
Superphosphate at Nil (P0)	531	757	757	681
56 lb. per acre ... (P1)	865	907	835	869
112 lb. per acre... (P2)	983	935	886	934
N effect	793	866	826	

Main Effect S.E. ± 28

Interaction S.E. ± 49

The significant interaction is of particular interest showing nitrogen only significantly increasing yield in the absence of phosphate, and similarly phosphate failing to increase significantly yields in the presence of the higher rate of nitrogen.

It is possible that at this site the sulphur contents of both fertilisers are influencing the response, and this possible effect is to be further investigated.

GROUNDNUTS

(a) *Yola, Adamawa Province*.—Experiments previously carried out at Yola to determine the cause of poor crop growth in the area had indicated a severe nutrient deficiency, probably of phosphate, with additional trace elements exerting a marked beneficial effect in the presence of adequate nitrogen and phosphate. In order to ascertain the rates of application of sulphate of ammonia and superphosphate required to obtain adequate nitrogen and phosphate levels, heavy dressings of both fertilisers alone and in combination were tested in an experiments of 4 randomised block each of 12 plots, and a summary of the results is presented in Table 92.

TABLE 92.—FERTILISER TRIAL ON GROUNDNUTS, YOLA

	<i>Kernels lb./acre</i>	<i>Haulms lb./acre</i>
<i>Sulphate of Ammonia</i>	N.S.	***
Nil (N0)	873	1,104
1 cwt per acre (N1)	806	1,526
2 cwt. per acre (N2)	759	1,665
S.E.	±41	±53
<i>Superphosphate</i>	N.S.	***
Nil (P0)	845	990
1 cwt. per acre (P1)	794	1,575
2 cwt per acre (P2)	841	1,603
2 cwt per acre (P3)	777	1,570
S.E.	±47	±61

The results are disappointing, both fertilisers significantly increasing the yield of haulms only, and this is probably a pure sulphur effect. The interaction NxP was insignificant, but a trend was apparent showing negative interaction between the two fertilisers, producing decreases in yield in the presence of each other. The increases produced by either fertiliser in the absence of the other is also disappointing, a 3 cwt dressing of superphosphate only producing small increase of 126 lbs. of kernels per acre despite the fact that the same treatment almost doubled the haulm yield.

Investigation into the fertility problems of the soils of this area are to be continued by the Chemistry Section.

(b) *Sokoto Province*.—Higher than normal dressings of superphosphate were also used on the observation trial conducted at Sokoto to determine the effects of various levels of nitrogenous and phosphatic fertilisers on the yield of millet and groundnuts. Unfortunately the millet yields were too low to give any true indication of fertiliser response and therefore Table 93 contains the yield of groundnuts only, where N0, N1 and N2 = Nil, $\frac{1}{2}$ cwt. and 1 cwt. per acre of sulphate of ammonia; and P0, P1 and P2 = Nil, 1 cwt. and 2 cwt. of superphosphate per acre.

TABLE 93.—FERTILISER TRIAL ON GROUNDNUTS. SOKOTO
lb. kernels per acre

	N0	N1	N2	Effect
P0	699	484	887	690
P1	807	914	807	843
P2	860	1049	726	878
Effect	789	816	807	

Responses were obtained from both levels of superphosphate alone and from the higher level of sulphate of ammonia alone as well as from the combined dressings.

(c) *Zaria Province*.—Two crops were also used in the experiment carried out at Zonkwa in Zaria Province, the groundnuts being followed by Dauro planted in mid-August to mid-September. The trial was conducted on farmers' own farms in the area, and a summary of the results on both crops is presented in Table 94.

TABLE 94.—FERTILISER TRIAL ON GROUNDNUTS AND DAURO, ZONKWA
lb. per acre

						<i>Dauro Grain</i>	<i>Groundnut Kernels</i>
Sulphate of Ammonia						N.S.	*
Nil (N0)						716	335
56 lb./acre (N1)						741	396
112 lb./acre (N2)						736	386
Superphosphate						**	***
Nil (P0)						662	322
56 lb./acre (P1)						729	376
112 lb./acre (P2)						802	420
S.E.						± 28	± 17

Significant responses were obtained on both crops to the 1 cwt. of superphosphate application, and also to the $\frac{1}{2}$ cwt. dressing in the case of groundnuts. The response to dressing of sulphate of ammonia was also significant in the groundnut crop, but no significant residual effect was obtained from the following dauro.

(d) *Plateau Province*.—In this, the first series of groundnut fertiliser trials carried out at Langtang, normal rates of application of sulphate of ammonia and superphosphate for farmers' own farm trials were used, and a summary of the results on both kernel and haulms is presented below in Table 95.

TABLE 95.—FERTILISER TRIAL ON GROUNDNUTS, LANGTANG
Yields in lb. per acre

Kernels

		N0	N1	N2	P. Effect
N.	P0	1,016	1,856	1,600	1,491
	P1	1,720	1,800	1,776	1,766
	P2	1,816	1,776	1,768	1,787
	** Effect	1,517	1,811	1,715	

Main Effects			Interaction **
S.E.	± 68		± 118
Haulms			
N0	N1	N2	P. Effect
1,086	2,816	2,424	2,107
2,520	2,888	2,648	2,686
3,000	3,368	2,872	3,080
**			
N.	2,107	3,024	2,648
Main Effects			Interaction N.S.
	± 171		± 296

The significant interaction of N and P on the yield of kernels is of particular interest in view of the previously reported sulphur deficiency on groundnuts. Sulphur is the only common factor occurring in any quantity in the composition of two fertilisers and the negative interaction indicates the possibility that the sulphur content of both fertilisers is probably responsible for a large part of the yield increases.

YAMS

(a) *Ilorin Province*.—Previously reported results 1954-55 Annual Report) have shown that in the Ballah, Okeoyi and Paiye districts of Ilorin province, economic increases in the yield of yams could be expected from an application of up to 1 cwt. of sulphate of ammonia per acre, but that the response to phosphate required further investigation before any recommendations could be made for its use.

In order to ascertain the response to a high rate of nitrogen application the design of the 1955 trials was altered to include a dressing of 168 lb. of sulphate of ammonia per acre, the higher nitrogen levels being tested in the presence and absence of a dressing of 1 cwt. per acre of superphosphate.

As in previous years two trials were carried out in each of the districts, each trial consisting of five randomised blocks of six treatments. Results from the six trials are presented in Table 96, together with a combined analysis, all yields being in lb. of tubers per acre.

The combined analysis figures indicate increments of 1,301, 1,302 and 523 lb. of yams per acre for each additional application of 56 lb. of sulphate of ammonia per acre over nil. The optimum rate of application therefore lies between 112 and 168 lb. per acre, comparing favourably with the

provisional recommendation made in 1955 of 1 cwt. per acre application in Ilorin Province. Increments due to the addition of 1 cwt. per acre of superphosphate are 680 lb. in the presence of 112 lb. of sulphate of ammonia and 807 lb. in the presence of 168 lb. per acre of sulphate of ammonia, both being of an economic nature.

TABLE 96.—YAM RESPONSES TO FERTILISERS IN ILORIN PROVINCE
Yields and differences from nil level in lb. tubers per acre

Centre	Ballah		Okeoyi		Paiye		Combined Analysis
No Manure (n0p0)	8,782	9,460	4,177	2,879	6,425	2,978	6,472
56 lb. N (n1p0)	+1,815	+1,227	+916	+1,615	+658	+839	+1,301
112 lb. N (n2p0)	+2,324	+2,404	+2,164	+1,831	+3,253	+2,272	+2,603
168 lb. N (n3p0)	+3,413	+4,171	+1,939	+2,684	+2,547	+2,429	+3,116
112 lb. N + 112 lbs P (n2P1) ...	+2,570	+2,986	+3,775	+2,970	+2,770	+2,832	+3,283
168 lb. N + 112 lbs P (n3p1) ...	+4,702	+3,274	+2,379	+2,393	+4,295	+3,998	+3,923
S.E. ...	±615	±763	±364	±335	±627	±411	±279

(b) *Benue Province.*—Previous results on Yams in Benue Province have indicated highly significant increases in yields from applications of up to 2 cwts. of sulphate of ammonia per acre. These results have been confirmed in the current year's trial at M'batie Tractor Unit Farm, where the effects of nitrogenous, phosphatic and potassic fertilisers were tested on both early and late planted yams. Results from the trial are presented in Table 97.

TABLE 97.—EFFECT OF FERTILISERS ON YIELD OF YAMS, M'BATIE
Yields and Differences over nil in lb. of tubers per acre

Main Effects						Early Yams	Late Yams	Combined early and late yams
<i>Season</i>								***
Early Yams	...	...	...	...	...			14,550
Late Yams	...	...	...	...	...			— 4,735
S.E.	...	...	...	...	...			±271
<i>Sulphate of Ammonia</i>						***	**	***
Nil (N0)	...	...	...	...	...	10,886	8,580	9,743
112 lbs/acre (N1)	...	...	...	...	...	+4,197	+1,286	+2,745
224 lbs/acre (N2)	...	...	...	...	...	+6,764	+2,418	+4,597
<i>Superphosphate</i>						N.S.	N.S.	N.S.
Nil (P0)	...	...	...	...	...	14,140	9,911	12,039
112 lbs/acre (P1)	...	...	...	...	...	+746	+468	+607
224 lbs/acre (P2)	...	...	...	...	...	+453	—756	—152
<i>Murate of Potash</i>						N.S.	N.S.	N.S.
Nil (K0)	...	...	...	...	...	14,759	9,739	12,261
56 lbs/acre (K1)	...	...	...	...	...	—641	+59	—292
112 lbs/acre (K2)	...	...	...	...	...	—17	+178	+80
S.E.	...	...	...	...	...	±472	±441	±332

Two of the interactions proved to be significant, and these are presented in Table 98.

TABLE 98
Season x Nitrogen

					N0	N1	N2
Early Planted	...	...	...	...	10,893	15,094	17,662
Late Planted	...	...	...	...	8,580	9,866	10,998
S.E. = ± 469							

Nitrogen x Phosphate

					N0	N1	N2
P0	...	...	...	...	11,533	14,077	16,810
P1	...	...	...	...	11,839	15,991	16,828
P2	...	...	...	...	9,286	15,181	19,311
S.E. = ± 818							

The results clearly indicate that not only can a greater yield be expected from early planted yams as compared with late planted, but also that greater yield increments are attained by applying the sulphate of ammonia dressing to the early planted yams. It is interesting to note, for practical purposes, that an application of 2 cwt. of sulphate of ammonia to early planted yams gives more than twice the yield of non fertilised late planted yams.

Trials carried out on farmers' own farms in Idoma Division of Benue Province did not, however, produce results at all comparable with those obtained at M'batic, general yields being much lower (despite early planting) and the response to fertilisers negligible. The results presented in Table 99 were obtained from four farms each containing one randomised block of five plots. No significant differences were recorded in the experiment and the high coefficient of variation (25 per cent of G.M.) is considered indicative of unreliable results.

TABLE 99.—FERTILISER TRIAL ON YAMS, IDOMA
Yields of Yams tubers in lb. per acre

No Manure	...	...	...	...	...	4,305
1½ cwt. N+1 cwt. P+½ cwt. K	...	...	...	...	...	4,235
1 cwt. N+1 cwt. P+¾ cwt. K	...	...	...	...	...	4,815
1½ cwt. N+1 cwt. P+¾ cwt. K	...	...	...	...	...	5,650
1 cwt. N+1 cwt. P+½ cwt. K	...	...	...	...	...	5,720

(c) *Kabba Province*.—An experiment comprising six randomised blocks each of six plots designed to determine the relative effects of sulphate of ammonia, superphosphate and their combinations at different levels on the yield of yams was carried out at the newly opened Osara Experimental Farm in Kabba Province during 1955. The effect of both the nitrogenous and phosphatic fertilisers was significant, the single and double rates of sulphate of ammonia producing increases of 2,354 and 1,718 lb. of yams per acre res-

pectively, 1 cwt. of superphosphate producing an increase of 1,422 lb. of yams per acre. The results of the experiment are presented in Table 100.

TABLE 100.—EFFECTS OF FERTILISERS ON YAMS, OSARA

Yields and differences over nil in lb. tubers per acre

<i>Sulphate of Ammonia</i>									***
Nil	(N0)	...	...	...	...	...	...	...	4,042
112 lb./acre	(N1)	...	...	...	...	...	...	...	+2,534
221 lb./acre	(N2)	...	...	...	...	...	...	...	+1,718
S.E.	...	...	...	...	...	...	...	...	± 325
<i>Superphosphate</i>									**
Nil	(P0)	...	...	...	...	...	...	...	4,688
112 lb./acre	(P1)	...	...	...	...	...	...	...	+1,422
S.E.	...	...	...	...	...	...	...	...	± 265

Similar results were also obtained from a yam observation trial at Dekina in Kabba Province where the effects of the following treatments were observed on one replication only:

- Main Treatments ... (a) No manure
 (b) 1 cwt. sulphate of ammonia per acre.
 (c) 1 cwt. S/A and 1 cwt. superphosphate per acre.
- Sub Treatments ... (a) Nil.
 (b) 75 lb. muriate of potash per acre.

Final yield figures indicated a response of 1,670 lb. yams due to the application of sulphate of ammonia, and the addition of superphosphate produced a further increment of 1,404 lb. making a total increase of 3,084 lb. of yams per acre for the mixture over nil. The application of muriate of potash however reduced the yield of tubers by 1,100 lb. per acre.

GRAIN CROPS

(a) Ilorin Province:

(1) *Early Maize interplanted with guineacorn*.—Ballah District.—Previous results obtained from Ballah district had indicated average percentage increases of 24.9 and 40.5 for applications of 60 lb. and 120 lb. of sulphate of ammonia per acre respectively and although the phosphate effect was less marked, the combined interaction table had clearly indicated the value of applying a mixed dressing of both fertilisers.

The results confirm previous findings, indicating significant increases due to applications of phosphate, with no significant difference between the two rates of application. No significant increases due to nitrogen applications were observed but indications of a positive interaction effect between the two fertilisers are present.

At Paiye significant residual effects on the interplanted guineacorn were obtained in both experiments, these residual results being presented in Table 104.

TABLE 104.—FERTILISER TRIAL ON MAIZE INTERPLANTED WITH
GUINEACORN, PAIYE
Guineacorn in lb. grain per acre

	N0	N1	N2	<i>Perfect</i> ***	N0	N1	N2	<i>Perfect</i> ***
P0 ...	431	384	370	395	330	353	307	330
P1 ...	467	515	511	498	413	494	446	451
P2 ...	672	560	602	611	502	546	506	518
N effect	524	486	494		415	464	420	
S.E. Interaction	= ± 42					± 50		
S.E. Main effects	= ± 24					± 29		

In both experiments superphosphate alone exerted a significant residual effect on the guineacorn yields, amounting to 103 lb. and 216 lb. for the $\frac{1}{2}$ cwt. and 1 cwt. per acre dressings in one trial, and 121 lb. and 188 lb. in the other. The difference between the two rates was significant ($P = 0.01$) in the former.

The average maize and guineacorn increments for some of the mixtures are presented in Table 105.

TABLE 105.—INCREMENTS OF GRAIN, PAIYE TRIALS
lb. grain per acre

<i>Treatment</i>				<i>Guineacorn</i>	<i>Maize</i>	<i>Total Grain</i>
P1	...	...	...	60	154	214
P2	...	...	...	207	234	441
N1P1	...	...	...	124	279	403
N2P2	...	...	...	174	326	500

(2) *Guineacorn interplanted through early maize.*—Similar results to those reported for the maize crop had also previously been obtained when the various treatments were applied directly to the guineacorn. The layout,

rates and design of the six interplanted 1955 trials (two at each site) were identical at all sites and exactly the same as those described in the 1954 Annual Report. The summary of yields giving the main effects for each experiment and the average interaction for each site is presented in Tables 106 and 107.

TABLE 106.—FERTILISER TRIAL ON GUINEACORN INTERPLANTED
THROUGH MAIZE, ILORIN
lb. guineacorn grain per acre

Site				Okeoyi		Ballah		Paiye	
<i>Sulphate of Ammonia</i>				**	***	***	***	*	N.S.
Nil	(N0)	...	...	231	327	727	462	436	489
60 lbs/acre	(N1)	...	...	329	391	861	593	509	519
120 lbs/acre	(N2)	...	...	483	522	913	667	515	522
S.E.	...	...	...	±39	±23	±19	±22	±17	±31
<i>Superphosphate</i>				N.S.	N.S.	*	N.S.	***	*
Nil	(P0)	...	...	324	394	811	548	379	462
60 lbs/acre	(P1)	...	...	372	433	857	600	594	558
S.E.	...	...	...	±32	±19	±15	±18	±14	±25

TABLE 107.—FERTILISER TRIALS ON GUINEACORN INTERPLANTED
THROUGH MAIZE, ILORIN

				<i>lb. guineacorn grain per acre</i>				<i>Paiye</i>	
				<i>Okeoyi</i>		<i>Ballah</i>			
				P0	P1	P0	P1	P0	P1
N0	...	...	...	276	284	571	618	428	498
N1	...	...	...	328	392	708	746	421	607
N2	...	...	...	472	534	760	821	412	625

The results indicate that the guineacorn responses are similar in each area to the responses of the maize crop, i.e. the major response at Okeoyi and Ballah is to the nitrogen carrier and at Paiye to the phosphate carrier. However in all cases the greatest increment is again obtained with a mixed dressing of sulphate of ammonia and superphosphate.

In previous years no effects on the maize crop were observed when fertilisers had been applied to the guineacorn. In the current series of trials however, significant differences were observed and a summary of maize yields is presented together with the average interaction for each site in Tables 108 and 109.

TABLE 108.—FERTILISER TRIAL ON GUINEACORN INTERPLANTED THROUGH MAIZE, ILORIN

Summary of Maize Yields in lb. of grain per acre

Site					Okeoyi		Ballah		Paiye	
<i>Sulphate of Ammonia</i>					N.S.	N.S.	*	**	**	N.S.
Nil	...	...	...	...	191	280	942	752	607	705
60 lbs/acre	...	...	...	...	177	313	963	885	671	701
120 lbs/acre	...	...	...	...	190	327	1,173	929	710	756
S.E.	...	...	...	...	±18	±18	±58	±31	±19	±30
<i>Superphosphate</i>					N.S.	N.S.	N.S.	N.S.	*	N.S.
Nil	...	...	...	...	184	306	1,029	844	638	696
60 lbs/acre	...	...	...	...	188	308	1,023	867	687	746
S.E.	...	...	...	...	±15	±14	±48	±25	±15	±25

TABLE 109.—FERTILISER TRIAL ON GUINEACORN INTERPLANTED THROUGH MAIZE, ILORIN

Summary of Maize Yields in lb. grain per acre

				Okeoyi		Ballah		Paiye	
				P0	P1	P0	P1	P0	P1
N0	...	...	...	247	224	860	834	671	640
N1	...	...	...	235	255	914	936	639	734
N2	...	...	...	253	265	1037	1066	691	775

In both experiments at Ballah significant increases of maize were observed due to applications of sulphate of ammonia to the interplanted guineacorn, while in one trial at Paiye both the sulphate of ammonia and superphosphate applications exerted significant effects.

The total maize and guineacorn increments for the average response to all treatments at the three sites are presented in Table 110.

TABLE 110.—GRAIN INCREMENTS FROM FERTILISER TREATMENTS
lb. per acre

Treatment	Okeoyi			Ballah			Paiye		
	Maize	G'corn	Total	Maize	G'corn	Total	Maize	G'corn	Total
P1	—23	+8	—15	—26	+47	+21	—31	+70	+39
N1	—12	+52	+40	+54	+137	+191	—32	—7	—39
N2	+6	+196	+202	+177	+189	+366	+20	—16	+4
N1P1	+8	+116	+124	+76	+175	+251	+63	+179	+242
N2P1	+18	+258	+276	+200	+250	+450	+104	+197	+301

As discussed under the results of guineacorn in Plateau Province, the high cost of transport of fertilisers compared with the low returns from guineacorn necessitates large increments from the treatments before they can be considered economic, and these responses do not approach an economic level.

(3) *Guineacorn interplanted through fertilised early Maize.*—The final direct fertiliser experiment in Ilorin Province was carried out at Ilorin Experimental Farm and was designed to ascertain whether economic increases could be obtained on guineacorn by various fertiliser applications when the crop was planted through early maize which had received the recommended fertiliser mixture.

The results, presented in Table 111, indicate that further fertiliser application to the intercrop is not of economic value, no significant differences due to treatments having been obtained.

TABLE 111.—FERTILISER TRIAL ON GUINEACORN INTERPLANTED
THROUGH FERTILISED EARLY MAIZE
lb. guineacorn grain per acre

				N0	N1	N2	<i>P. effect</i>
P0	...	...	...	516	484	563	521
P1	...	...	...	421	583	481	495
P2	...	...	...	524	473	610	536
N. effect	...	...	...	487	514	551	

S.E. = ± 36 (Main effects) = ± 62 (Interaction)

N0: N1 and N2 = 0:56 and 112 lbs of sulphate of ammonia per acre

P0: P1 and P2 = 0:56 and 112 lbs of superphosphate per acre.

(4) *Early Maize and Guineacorn Residual Trials.*—One residual trial was carried out at each of the three centres to ascertain the residual effect on early maize inter-planted with guineacorn, of fertilisers applied to the Yam crop in 1954. Unfortunately both Paiye and Okeoyi germination was very poor and both experiments had to be entirely replanted. The resultant late plants were severely attacked by animals and the results from both trials were not considered reliable. At Ballah, however, reliable results were obtained and a summary of yields for both crops is presented in Table 112.

TABLE 112.—RESIDUAL FERTILISER TRIAL ON MAIZE AND
GUINEACORN, BALLAH
lb. grain per acre

							Maize	Guineacorn
<i>Residual Effect of Sulphate of Ammonia</i>							*	N.S.
Nil	(N0)	...	...	...	...	...	696	480
60 lbs/acre	(N1)	...	...	...	...	...	671	481
120 lbs/acre	(N2)	...	...	...	...	...	814	513
S.E.	...	...	...	...	...	...	±43	±28
<i>Superphosphate</i>							***	*
Nil	(P0)	...	...	...	...	...	626	447
60 lbs/acre	(P1)	...	...	...	...	...	828	536
S.E.	...	...	...	...	...	...	±35	±23

The results show that not only has the 60 lb. per acre dressing of superphosphate applied to yam crop in 1954 exerted a highly significant residual effect on the 1955 maize crop of 202 lb., but also even upon the later interplanted Guineacorn of 89 lb. Even more surprising the higher level of sulphate of ammonia exerted a similar effect, it's residual value significantly increasing the yield of maize by 118 lb., and that of the following guineacorn by 33 lb., the latter increase not being significant.

(b) *Katsina Province: Guineacorn Daudawa*.—An experiment carried out at this station indicated no significant residual effects on guineacorn from a dressing of 56 lb. of superphosphate applied at various times also to guineacorn in the previous year.

A summary of the results in lb. of grain per acre is presented in Table 113.

TABLE 113.—RESIDUAL TRIAL ON GUINEACORN, DAUDAWA
lb. grain per acre

Superphosphate applied at 4 leaf stage	...	...	...	...	1248
Superphosphate applied at 2 leaf stage	...	...	...	...	1222
Superphosphate applied at planting stage	...	...	...	...	1152
No manure	...	...	...	...	1127
S.E.	...	...	...	...	±35

(c) *Adamawa Province: Guineacorn*.—Results previously obtained from Yola had indicated a major nutrient deficiency, probably phosphate as being the causative factor of the poor crop growth in the area. To confirm

this finding, heavy rates of application of both nitrogen and phosphate were tested alone and in combination in a randomised block experiment, using guineacorn as the test crop. Rates of application were nil, 1 cwt., 2 cwt., and 3 cwt. of superphosphate, and nil, P0, P1, P2, P3 and N0, N1, N2 respectively in the summary of yields presented in Table 114.

TABLE 114.—FERTILISER TRIAL ON GUINEACORN, YOLA
lb. grain per acre

				P0	P1	P2	P3	N. effect**
N0	...	...	...	863	1009	1127	891	972
N1	...	...	...	778	1370	1418	1294	1215
N2	...	...	...	948	1223	1263	1387	1205
P. effect***	...	...	...	865	1203	1272	1193	

S.E. (Main Effects) = ± 51 (N) S.E. (Interaction) = ± 101
= ± 59 (P)

The main effects of both fertilisers proved significant, the 1 and 2 cwt. dressing of sulphate of ammonia producing almost identical increases of 243 and 233 lb. of grain per acre respectively. All three levels of superphosphate produced highly significant increases of 338 lb., 407 lb. and 328 lb. of grain respectively.

Although not significant, the interaction is of interest indicating the depressing effect of the 3 cwt. dressing of superphosphate over the other levels except in the presence of 2 cwt. of sulphate of ammonia. It is considered that this effect indicates the need for a balanced mixture of both N and P, and not the application of superphosphate alone. It is of interest to note that similar trends were observed in a groundnut trial at Yola, using the same treatments.

A similar interaction trend was observed in the results from the experiment carried out at Mubi, despite the fact that the levels of fertilisers were of a lower order, being $\frac{1}{2}$ cwt. and 1 cwt. per acre dressings of both superphosphate and sulphate of ammonia. (Table 114A).

TABLE 114A.—FERTILISER TRIAL ON GUINEACORN, MUBI
Yields in lb. of grain per acre

					N0	N1	N2	P. effect
P0	...	...	...	...	240	591	446	426
P1	...	...	...	...	343	448	582	458
P2	...	...	...	...	284	540	725	516
N. effect***	...	...	...	...	289	526	584	

S.E. (Main Effects) = ± 45 S.E. (Interaction) = ± 78

(d) *Niger Province, Guineacorn.*—Two extension experiments on guineacorn were carried out in Niger Province during the year. Unfortunately at Lemu demonstration farm a very high standard error (57 per cent of G.M.) allows no reliance to be placed on the results which were extremely variable. At Wasagu however, where the experiment was carried out on farmers' own farms the effects of both nitrogen and phosphate proved significant as shown in Table 115.

TABLE 115.—FERTILISER TRIAL ON GUINEACORN, WASUGA

					<i>lb. grain per acre</i>			
					N0	N1	N2	Effect*
P0	...	...	...	...	496	504	620	540
P1	...	...	...	...	832	520	752	701
P2	...	...	...	...	536	656	804	665
Effect*	...	...	...	...	621	560	725	
S.E. (Main effects) = ±46					S.E. (Interaction) = ±80			

The S.E. of this experiment was however also high (28 per cent of G.M.) and this combined with suspicious yield for the N0P1 treatment indicates that not too much reliance should be placed on the trials results.

(e) *Benue Province, Guineacorn.*—Three series of trials were carried out in Benue Province during the season and a summary of results is presented in Table 116.

TABLE 116.—EXTENSION TRIALS, BENUE

					<i>lb. grain per acre</i>					
<i>Sulphate of Ammonia</i>					**		N.S.		***	
Nil	...	...	...	...	695		810		661	
56 lbs/acre	...	...	...	...	813		751		796	
112 lbs/acre	...	...	...	...	915		775		812	
<i>Superphosphate</i>					N.S.		***		N.S.	
Nil	...	...	...	...	807		506		727	
56 lbs/acre	...	...	...	...	825		838		776	
112 lbs/acre	...	...	...	...	791		992		765	
S.E.					±40		±44		±23	
<i>Interaction</i>					N.S.		N.S.		**	
					N0	N1	N2	N0	N1	N2
P0	...	...	...	...	728	744	948	566	502	451
P1	...	...	...	...	700	904	872	807	849	858
P2	...	...	...	...	658	792	924	1,057	900	1,017
S.E.					±68		±77		±41	

The results from the three sites are variable, those from Lafia indicating nitrogen to be the main deficiency with a negative interaction with phosphate. At both the other sites, however, the interaction between phosphate and nitrogen is not significant, though there is a suggestion of a depressing effect by Nitrogen alone in one case and by phosphate alone in the other.

(e) *Plateau Province, Guineacorn.*—(a) Lowlands Division-Yelwa.—Results comparable with previous trials were obtained and a summary of the three years results is presented in Table 117.

TABLE 117.—SUMMARY OF YELWA FARMERS' TRIALS, GUINEACORN
lb. dry grain per acre

Main Effects							1955	1954	1953(a)						
Sulphate of Amonia							***	***	N.S.						
Nil (N0)	...	...	...	...	...	...	601	592	610						
56 lb./acre (N1)	...	...	...	...	...	...	+79	+175	+58						
112 lb./acre (N2)	...	...	...	...	...	...	+202	+203	+55						
Superphosphate							***	***	***						
Nil (P0)	...	...	...	...	...	...	556	623	505						
56 lb./acre (P1)	...	...	...	...	...	...	+223	+124	+232						
112 lb./acre (P2)	...	...	...	...	...	...	+194	+161	+196						
S.E.							...	...	...	...					
							±28	±30	±48						
Interaction							N.S.	N.S.	N.S.						
							N0	N1	N2	N0	N1	N2			
P0	...	...	...	...	...	...	499	514	654	522	741	605	472	511	532
P1	...	...	...	...	...	...	646	827	864	601	743	896	657	802	752
P2	...	...	...	...	...	...	659	699	891	652	816	883	701	690	712

(a) Rates of fertiliser application for the 1953 trials were 50 and 100 lb. per acre of each fertiliser.

Although the individual interactions are not significant, when combined they indicate a considerable positive NxP interaction as shown in Table 118.

TABLE 118.—NxP. INTERACTION OF COMBINED
THREE YEARS RESULTS
lb. dry grain per acre

			N0	N1	N2
P0	...	...	498	589	597
P1	...	...	635	791	837
P2	...	...	671	735	829

The increase due to an application of N2 in the absence of P is 99 lb. per acre and that due to a P1 application in the absence of N is 137 lb., giving total of 236 lb. The actual increase due to an application of N2P1 is, however, 339 lb., giving a very significant additional increment of 103 lb. due to the interaction effect.

(b) *Southern Division, Andaha.*—The results from previous two years' trials were also available in this area and a summary of these together with the current year's results is presented in Tables 119 and 120.

Although the results are more variable than those obtained at Yelwa, they do indicate a similar positive interaction effect due to the combination of both fertilisers and also that the most economic dressing is again $\frac{1}{2}$ cwt of sulphate of ammonia and $\frac{1}{2}$ cwt of superphosphate per acre.

TABLE 119.—SUMMARY OF ANDAHA FARMERS' TRIALS
lb. dry grain acre

<i>Main Effect</i> <i>Sulphate of Ammonia:</i>					1955 N.S.			1954 *			1953(a) ***		
Nil	(N0)	...	...		549			514			587		
56 lb./acre	(N1)	...	...		+40			+88			+106		
112 lb./acre	(N2)	...	...		+55			+70			+105		
<i>Superphosphate:</i>					*			*			***		
Nil	(P0)	...	...		496			530			506		
56 lb./acre	(P1)	...	...		+116			+27			+229		
112 lb./acre	(P2)	...	...		+139			+83			+226		
<i>Interaction</i>					N.S.			N.S.			**		
					N0	N1	N2	N0	N1	N2	N0	N1	N2
P0	...	...	...	...	448	476	564	492	583	515	492	495	533
P1	...	...	...	...	572	672	592	502	585	583	668	822	719
P2	...	...	...	...	628	620	656	548	637	653	606	766	829

(a) Rates of application for the 1953 trial were 0:40 and 80 lb. per acer of sulphate of ammonia per acre and 0:60 and 120 lb. of superphosphate per acre.

TABLE 120.—NxP. INTERACTION TABLE OF COMBINED
THREE YEARS' RESULTS
lb. dry grain per acre

				N0	N1	N2
P0	...	...		477	518	537
P1	...	...		581	693	631
P2	...	...		594	674	713

(c) *Lowlands Division, Langtang.*—The first trial carried out in this area in 1954 suffered from a heavy attack of stem borer and the experiment had to be considered a failure. Reliable results were however obtained from the 1955 trial, a yield summary of which is presented below in Table 121.

TABLE 121.—LANGTANG FARMERS' TRIALS, GUINEACORN

			<i>lb. dry grain per acre</i>			
			N0	N1	N2	<i>P. effect*</i>
P0	...	...	242	407	393	348
P1	...	...	286	356	396	338
P2	...	...	316	326	468	371
N. effect***			282	364	411	

The results show that significant differences were obtained from applications of both the phosphatic and the nitrogenous fertilisers the dressings of $\frac{1}{2}$ cwt and 1 cwt of sulphate of ammonia per acre producing increases of 82 lb. and 129 lb of grain per acre respectively. The significance of the phosphate application is however due to the difference of 33 lb per acre between the two rates and neither $\frac{1}{2}$ nor 1 cwt. superphosphate yielded significantly differently from nil.

The highly significant interaction between the two types of fertiliser is negative in character with the exception of the N2P2 increase of 226 lb., where it is nil, the increases due to P2 alone and N alone totalling 225 lb.

2.—LATE DAURO

Jema'a Division, Kafanchan.—In this trial the first carried out on late dauro in the area, the final results show highly significant increases in yield due to both the $\frac{1}{2}$ cwt. and the 1 cwt. dressing of sulphate of ammonia, the higher rate of application also being significantly (**) better than the lower level. Neither the superphosphate dressing nor the NxP interaction produced significant responses, as shown in Table 122.

TABLE 122.—JEMA'A FARMERS' TRIALS, LATE DAURO

			<i>lb. grain per acre</i>			
			N0	N1	N2	<i>P. effect</i>
P0	...	...	549	769	858	725
P1	...	...	681	761	880	774
P2	...	...	610	816	917	781
N. effect***			613	782	885	

S.E. (Main Effects) = ± 26 S.E. (Interaction) = ± 45

B.—FERTILITY INVESTIGATION

1. *Sulphur Deficiency.*—Results previously obtained in the Northern Region have indicated that both the sulphur and the phosphate contents of superphosphate contribute to the increases of haulm and kernel yields of

the groundnut crop. Trials have also indicated that the available sulphur in Northern Region soils is marginal as regards the requirement of the groundnut crop and that in certain areas the lack of available sulphur may become a limiting factor.

No information on the sulphur response was however available from the Ilorin area and an attempt was made to rectify this omission during the year. Analysis of the final yield figures from the trial, however, showed an S.E. of 51.5 per cent of the general mean for haulms and the results had therefore to be considered unreliable.

The residual effects of the 1954 applications of triple-super, super-phosphate and gypsum were tested at three stations during the year, the test crops used being groundnuts at Kontagora and Kafinsoli and guineacorn at Daudawa (*see* Table 123).

TABLE 123.—RESIDUAL SULPHUR AND PHOSPHATE TRIALS
lb. dry grain per acre

1954 Dressing	Kontagora		Kafinsoli		Daudawa
	***	**		**	
	Kernels	Haulms	Kernels	Haulms	Guineacorn
No manure	440	621	630	908	1329
38.7 lb. gypsum	419	644	678	1063	1365
77.4 lb. gypsum	480	726	713	995	1382
32.2 lb. triplesuper	505	785	653	991	1258
60.0 lb. single super	546	832	733	1211	1391
64.4 lb. triplesuper	598	895	671	939	1504
120.0 lb. single super	640	945	734	1153	1626
S.E.	±33	±54	±38	±48	±82

Although no significant results were obtained at Daudawa the higher levels of both single and triple-superphosphate had a marked residual effect, increasing the yield of guineacorn by 297 and 175 lb. of grain per acre respectively. The Kafinsoli results indicate significant ** increases in haulm yields due to the residual effects of both levels of application of super-phosphate and the equivalent P205 dressings of triplesuper not containing sulphate. At Kontagora, on the other hand, both the single and triple superphosphate applications gave significant residual effects on both kernel and haulm yields, with no significant differences due to the type of phosphate carrier.

It is considered that sufficient information has now been obtained to confirm the original choice of single superphosphate as the phosphatic fertiliser for use on groundnuts in preference to triple superphosphate on account of the former's high sulphur content. With other crops, however, sufficient information is not yet available to justify the use of the higher

transport costs on single in preference to triple superphosphate. Information is also required on the causes of sulphur deficiency and it is worthy of note that large increases in the yields of kernels have been obtained only under conditions of waterlogging or on land newly opened from bush.

In order to ascertain if sulphur exerted a beneficial effect on the yield of guineacorn and also to confirm that increases from applications of sulphate of ammonia were due to its nitrogen content and not its sulphur content, an experiment testing the effects of various nitrogenous fertilisers was carried out at Samaru. The treatments used were (a) 56 lb. per acre of sulphate of ammonia; (b) urea equal in N content to (a); (c) Ammonium Chloride equal in N content to (a); (d) sodium sulphate equal in S content to (a) and (e) no manure. Six randomised blocks each of five plots were used in the trial, the results of which are presented in Table 124.

TABLE 124.—FERTILISER TRIAL ON GUINEACORN, SAMARU

<i>lb. grain per acre</i>						
(e)	No manure	...	...	...	...	658
(d)	60 lb. sodium sulphate	...	...	...	...	678
(c)	45 lb. ammonium chloride	...	...	...	...	736
(b)	26 lb. urea	...	...	...	...	772
(a)	56 lb. sulphate of ammonia	...	...	...	...	793
	S.E.	...	...	...	...	±27

2. *Trace Elements, Dambatta*.—Reports received from the experimental farm at Dambatta in Kano Province, have shown consistently low groundnut yields despite applications of superphosphate and compost; and associated with these poor yields, a very low shelling percentage. The yield of 136 lb. per acre of unshelled groundnuts in 1951 with an application of 1 ton of compost per acre can be considered typical.

The problem was considered to be of a nutritional nature and in 1954 the effects of heavy dressings of artificial fertilisers and farmyard manure, up to 9 ton per acre, were tested. Yields of kernels, however, and shelling percentages remained of a very low order, the highest kernels yield obtained being 335 lb. per acre.

In 1955, therefore, a further trial was carried out testing the effects of a mixed dressing of superphosphate and sulphate of ammonia, alone and in combination with a trace element mixture. In addition to this randomised block arrangement, observation plots were laid down to test the effect of lime and potash dressings. The trace elements were applied by spraying on to the appropriate plots before planting and consisted of Magnesium Sulphate (40 lb./acre) Boric Acid (20 lb./acre); Manganese sulphate (30 lb./acre); Zinc Sulphate (30 lb./acre); Copper sulphate (20 lb./acre) and

Molybdenum Sulphate (1 lb./acre). The rates of application for the fertilisers and lime were as follows:

(P) Superphosphate	...	...	...	...	...	2 cwt. per acre
(N) Sulphate of Ammonia	...	...	...	...	...	$\frac{1}{2}$ cwt. per acre
(K) Muriate of Potash	...	...	...	...	...	$\frac{1}{2}$ cwt. per acre
(L) Awgu Lime	...	...	...	...	...	3 cwt. per acre

A summary of kernel yields together with the shelling percentages is presented in Table 125.

TABLE 125.—TRACE ELEMENT TRIAL DANBATT

Treatment						Kernels lb./acre	Shelling Percentage
Trace Elements	...	...	...	...	...	402	32.9
No manure	...	...	...	...	...	742	42.0
N plus P	...	...	...	...	...	848	53.5
N plus P plus Trace Elements	...	...	...	...	...	948	53.8
S.E. = $\pm$	...	...	...	...	...	± 127	± 4.8
5% Sig. Diff.	...	...	...	...	...	382	14.5

Observation Plots

N.P.K.	...	...	...	...	...	546	49.1
N.P.	...	...	...	...	...	731	45.6
N.P.K.L. plus Trace Elements	...	...	...	...	...	1232	67.0
N.P.L. plus Trace Elements	...	...	...	...	...	1649	68.0

The 340 lb. per acre decrease due to the application of trace elements alone is undoubtedly due to the severe burning which this treatment caused to all plots on which it was applied. Even with this decrease, however, the addition of trace elements to the NP mixture increased yields by 100 lb. of kernels, indicating a considerable positive interaction between the mixture and the Trace Elements. (Table 126).

TABLE 126.—INTERACTION MAJOR x TRACE ELEMENTS

Kernel lb. per acre

						O	NP Mixture	Average
O	...	...	...	...	...	742	848	795
Trace Elements	...	...	...	...	...	402	948	570
Average	...	...	...	...	...	572	898	—

Unfortunately no comparison can be made of the yields from the experiment and those from the observation plots. Comparison of the latter however indicate, as is normal in the Region, a depressing effect from potash applications and a considerable increase due to the application of lime and trace elements.

Whether this increase is due to the trace elements, alteration of pH, addition of calcium, or the impurities in the lime is not known, but will be further investigated during the coming year.

3. *D.N.P.K. Trials.*—The standard series of trials, (34) incorporating annual dressings of f.y.m. nitrogenous, phosphatic and potassic fertilisers was continued at Daura, Samaru, Maiduguri, Yandev, Kano, Daudawa, Bida and Yola (modified) with the current crop of the local rotation.

Unfortunately at Daudawa a mistake occurred in splitting the nitrogen plots of one of the blocks, in an attempt to determine the relative contributions of nitrogen and sulphur to the sulphate of ammonia effect, and no analysis is available from this station. The data from all the other stations are presented in Table 127.

In the 1954-55 Report, Reference was made to the unexpected highly significant increase in haulm yields due to potash, but no indication of a similar effect on guineacorn was observed in the current year's trial. Similarly at Samaru, no repetition of the detrimental effect on yield of the higher level of application of superphosphate observed in the previous year, was recorded on the current crop of groundnuts.

The significant depressing effect of sulphate of ammonia on the yields of kernels at Daura, Samaru, and Yola is of interest, being also observed on the guineacorn at Kano and the cowpeas at Maiduguri.

The results as a whole follow the trend of past years, significant increases in yields from applications of f.y.m. being obtained at all stations. The same trend is also shown by superphosphate but the increases are of a lower order. The nitrogen response is variable according to the crop and station while, with the exception of Bida, the overall effect of potash is to reduce yields.

TABLE 127.—D.N.P.K. TRIALS
Yields and Differences from Nil Level in lb. per acre

Station	Treatment	Daura		Samaru		Maiduguri		Yandev	Kano	Bida	Yola
		Groundnuts Kernels	Haulms	Groundnuts Kernels	Haulms	Millet and Cowpeas Millet	Cowpeas	Bemiseed	Guineacorn	Cassava	Groundnuts Kernels
F.Y.M.	...	...	...	...	...	...	...	...	...	...	...
	D0 ...	554	756	787	1,264	1,208	N.S.	287	1,010	3,677	475
	D1 ...	-268	-103	-299	+547	+149	+5	+44	+407	+1,638	+1
	D2 ...	+454	+392	+391	+871	+156	+5	+30	+629	+2,489	+177
Nitrogen	...	...	...	...	...	...	...	...	...	...	...
	N0 ...	834	794	1,083	1,651	1,204	211	269	1,430	4,372	N.S.
	N1 ...	-52	+213	-86	+105	+92	-13	+48	-29	+844	587
	N2 ...	-67	+168	-112	+152	+226	-33	+81	-195	+1,198	-92
Phosphate	...	...	...	...	...	...	...	...	...	...	...
	P0 ...	602	774	850	1,444	1,263	149	296	1,210	4,723	N.S.
	P1 ...	+230	-183	+189	+335	+80	+58	+28	+117	+325	481
	P2 ...	+348	+259	+312	+544	+60	+81	+19	+318	+665	+30
Potash	...	...	...	...	...	...	...	...	...	...	...
	K0 ...	831	913	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	—
	K1 ...	-3	+5	1,032	1,736	1,297	187	311	1,383	4,954	—
	K2 ...	-107	+19	-23	-27	+20	+11	+5	-52	+176	—
S.E.	...	...	...	...	...	...	...	...	...	...	...
	...	±28	±41	±17	±31	±34	±9	±9	±45	±116	±35

LABORATORY WORK (T.B.M.)

Difficulty was experienced during the year in keeping abreast of the large numbers of samples requiring analysis. The exigency of competent staff is becoming greater as the demand for analytical work by other sections and outstations increases. Although the advent of new equipment has enabled the adoption of new techniques which are more rapid, the position is far from satisfactory.

A considerable number of proximate analyses have been carried out for the Grassland Section. These results illustrate the variations in pasture composition under different conditions and are reported under the Grassland Section. Feeding stuffs including groundnut cakes, dambara, rubdusa and silage were analysed for outstations.

Biochemical work, which began towards the end of the year, has been directed mainly to animal nutrition studies together with the analysis of certain food stuffs for vitamins in connection with plant breeding.

In conjunction with the Grassland Section digestibility trials with sheep are in progress. This forms a beginning to the determination of the nutritive value of local fodders which have been assessed up to date on assumed constants. When the necessary equipment arrives, it is intended to carry out in vitro studies of the mechanism of digestion by the rumen flora of Zebu cattle.

Silage.—The chemical analysis of sunflower silage from Daudawa was completed (Table 128). The experiment was designed to ascertain the optimum spacing and rate of manuring to give the highest yield of green tops for ensilage. A preliminary account was given in the Annual Report 1953-54 pp. 9 and 65.

TABLE 128.—MEAN PERCENTAGES OF CONSTITUENTS WITH RESPECT TO MANURIAL TREATMENTS AND SPACINGS

	<i>Dry Matter lb/acre</i>	<i>Crude Protein %</i>	<i>Crude Fibre %</i>	<i>N.F.E %</i>	<i>'Oil' %</i>	<i>CaO₂ %</i>	<i>PO₃ %</i>
<i>Farm Yard Manure (ton/acre)</i>	**	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>	*
Nil	1,396	7.5	33.08	40.21	1.90	2.6	0.64
3	1,646	7.3	34.90	38.84	1.90	2.5	0.72
6	1,854	7.5	33.77	39.08	2.00	2.5	0.73
<i>Spacings (Inches on 3 foot ridges)</i>	*	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>	<i>Not Sig.</i>
12	1,731	7.3	34.61	38.73	2.00	2.6	0.67
18	1,715	7.4	33.04	39.89	2.00	2.45	0.68
36	1,450	6.7	34.10	39.51	1.90	2.5	0.75
S.E. ...	79	0.36	0.85	0.98	0.21	0.22	0.09

The results indicate that the yield of dry matter is significantly increased by application of F.Y.M. and by close spacing. The levels of proximate constituents and CaO in the dry matter are not altered, but the application of F.Y.M. does enhance the content of P_2O_5 .

Irrigation Water.—Analyses of irrigation water of the Rima fadama in Sokoto Province were continued in co-operation with the Government Chemist in Kaduna.

Samples were taken from the well and lake at fortnightly intervals throughout the dry season. There were no significant fluctuations in the salt concentrations between samples from the same source with the exception of the lake samples, which showed a marked rise in concentration during May and June.

The calcium and sulphate levels were significantly higher in the well water throughout the season, whilst sodium chloride and bicarbonate were similar in both sources. This gave a more favourable ratio of Na/Ca in the well water rendering it more suitable for irrigation purposes. The levels of sodium relative to total salts concentration were well within the limits of suitability for irrigation in both sources.

TABLE 129.—CROP YIELDS ON PLOTS IRRIGATED WITH
WELL AND LAKE WATER

lb. per acre

	<i>Lake</i>	<i>Well</i>
Maize	1440	120
Cassava	740	3080
Sweet Potatoes	6700	6200
Onions	7860	12060
Wheat	1200	900
Tomatoes	15280	1400
Tobacco	2880	1320
Peppers	2860	1560
Garden Egg	4240	2620
Bitter Tomato	3700	3040

Table 129 gives the yields (non-replicated) of crops from plots which received well and lake water irrigation. With the exception of cassava and onions, all crop yields favour lake water as the more suitable for irrigation.

This finding is contrary to the conclusions drawn from the analytical data of the waters. Any reasons which can be offered to account for this anomaly are, at present, only speculative and further work on the field aspects of the problem are required.

Grain Storage.—The CO_2 content of the Argentine Grain Storage Tank was determined at weekly intervals throughout the year. The results are incorporated in the report of the Entomology Section.

VI. GRASSLAND SECTION

By A. Blair Rains and W. H. Foster

INTRODUCTION (A.B.R)

The transfer of staff and equipment from Samaru to Shika Stock Farm has been nearly completed. Shika is five miles from Samaru, and on the farm of approximately 3,000 acres there is land available for the development of Grassland work, and at the same time the two complementary investigations, cattle improvement and pasture research, are brought together.

For the first time sown plots have been large enough for grazing.

A considerable quantity of seed of selected species and strains has been collected and a limited amount of this seed has been issued to a number of provincial stations.

With the partial completion of some experiments and trials, the major problems are becoming apparent. Amongst these are the low protein and phosphorus levels in the majority of fodder crops, and associated with these low levels is the question of soil fertility particularly in terms of nitrogen; another serious problem is the difficulty of providing feeding during the latter months of the dry season. Conservation of material as hay or silage is not the complete answer.

Control of scrub growth is most necessary on land required for grazing; chemical arboricides are uneconomic, hand or mechanical cleaning can only be justified by arable cropping, but it is hoped that fire will provide some measure of control.

Trial on Effect of Cutting and Applying Sulphate of Ammonia to Grasses.—In this experiment four grasses, *Chloris gayana*, *Hyparrhenia rufa*, *Setaria sphacelata* and *Cenchrus ciliaris* are cut at four and eight-week intervals and half the plots receive 2 cwt. of sulphate of ammonia every eight weeks.

The experiment was established in 1954, and in the initial year plots were cut three times and two times respectively and there was one application of fertiliser.

In the second year plots were cut five times and two times and fertiliser was applied twice. In the results the fifth cut in 1955 has not been included. Yields in terms of dry matter are shown for 1954, 1955 and the two years combined in Table 130. Corresponding yields of crude protein appear in Table 131.

TABLE 130.—EFFECT ON DRY MATTER YIELDS OF CUTTING AND FERTILISING GRASSES, 1954 AND 1955

lb. Dry Matter per acre

	<i>Chloris</i>	<i>Hyparrhenia</i>	<i>Setaria</i>	<i>Cenchrus</i>	<i>Management Means</i>
<i>1954 Yields</i>					
S/A—4 weeks cwt	3,300	3,720	3,020	5,690	3,933
Nil—4 weeks cwt	3,800	3,610	2,465	3,650	3,381
S/A—8 weeks cwt	6,050	5,830	2,360	3,370	4,401
Nil—8 weeks cwt	4,040	5,480	2,630	2,430	3,645
Species Means	4,298	4,660	2,619	3,785	3,841
<i>1955 Yields</i>					
S/A—4 weeks cwt	3,370	4,350	4,180	3,560	3,865
Nil—4 weeks cwt	1,710	1,930	1,695	1,365	1,675
S/A—8 weeks cwt	5,300	5,710	5,100	3,670	4,945
Nil—8 weeks	2,400	3,590	3,510	1,565	2,766
Species Means	3,195	3,895	3,621	2,540	3,313
<i>1954 and 1955 Yields</i>					
S/A—4 weeks cwt	6,670	8,070	7,200	9,250	7,798
Nil—4 weeks cwt	5,510	5,540	4,160	5,015	5,056
S/A—8 weeks cwt	11,350	11,540	7,460	7,040	9,346
Nil—8 weeks	6,440	9,070	6,140	3,995	6,411
Species Means	7,493	8,555	6,240	6,325	7,154
			1954	1955	1954 and 1955
<i>Sulphate of Ammonia Means</i>					
With S/A			4,167	4,405	8,572
Without S/A			3,513	2,220	5,733
<i>Frequency of Cutting Means</i>					
4 weeks cuts			3,657	2,770	6,427
8 weeks cuts			4,023	3,855	7,878
<i>Standard Errors</i>					
Species Means			±571	±638	±1,130
S/A and Frequency Means			±366	±216	±451

TABLE 131.—EFFECT ON CRUDE PROTEIN YIELDS OF CUTTING AND FERTILISING GRASSES, 1954 AND 1955

lb. Crude Protein per acre and (Percentage of Dry Matter)

	<i>Chloris</i>	<i>Hyparrhenia</i>	<i>Setaria</i>	<i>Cenchrus</i>	<i>Management Means</i>
<i>1954 Yields</i>					
S/A—4 weeks	357 (10.8)	329 (8.8)	287 (9.5)	422 (7.4)	349 (8.9)
Nil—4 weeks	365 (9.6)	284 (7.9)	210 (8.5)	225 (6.2)	271 (8.0)
S/A—8 weeks	526 (8.7)	295 (5.1)	126 (5.3)	204 (6.0)	288 (6.5)
Nil—8 weeks	322 (8.0)	298 (5.4)	182 (6.9)	144 (5.9)	237 (6.5)
Species Means	393 (9.1)	302 (6.5)	201 (7.6)	249 (6.4)	286 (7.4)
<i>1955 Yields</i>					
S/A—4 weeks	338 (10.0)	390 (9.0)	405 (9.7)	320 (9.0)	363 (9.4)
Nil—4 weeks	124 (7.2)	119 (6.2)	138 (8.1)	102 (7.5)	121 (7.2)
S/A—8 weeks	406 (7.7)	423 (7.4)	413 (8.1)	304 (8.3)	387 (7.5)
Nil—8 weeks	92 (3.8)	268 (7.5)	136 (3.9)	69 (4.4)	141 (5.1)
Species Means	240 (7.5)	300 (7.7)	273 (7.6)	199 (7.8)	253 (7.6)
<i>1954 and 1955 Yields</i>					
S/A—4 weeks	695 (10.4)	719 (8.9)	692 (9.6)	742 (8.0)	712 (9.1)
Nil—4 weeks	489 (8.6)	403 (7.3)	348 (8.4)	327 (6.5)	392 (7.7)
S/A—8 weeks	932 (8.2)	718 (6.2)	539 (7.2)	508 (7.2)	675 (7.2)
Nil—8 weeks	414 (6.4)	566 (6.2)	318 (3.5)	213 (5.5)	378 (5.9)
Species Means	633 (8.3)	602 (7.0)	474 (7.6)	448 (7.1)	539 (7.5)
			1954	1955	1954 and 1955
<i>Sulphate of Ammonia Means</i>					
With S/A	...	...	319 (7.7)	375 (8.5)	694 (8.1)
Without S/A	...	...	254 (7.2)	131 (5.9)	385 (6.7)
<i>Frequency of Cutting Means</i>					
4 weeks cuts	...	...	310 (8.5)	242 (8.7)	552 (8.6)
8 weeks cuts	...	...	263 (6.5)	264 (6.8)	527 (6.7)
<i>Standard Errors</i>					
Species Means	...	...	±41.9	±49.2	±114
S/A and Frequency Means	...	...	±25.9	±17.9	±45

The 1955 results are probably of greater importance in indicating the effects of the treatments than those of 1954 or the combined 1954 and 1955 totals. In 1954 existing grass plots were cleared and the residue ploughed in. The decomposition of this material would make available some nutrients to the new plots.

The more frequent cutting depresses the yield of D.M. considerably but has little effect on the yield of C.P. The application of nitrogen doubles the yield of D.M. and trebles the yield of C.P. but only increases to the percentage C.P. by $2\frac{1}{2}$ per cent.

Trial of Effects of Spacing on Four Grasses.—See previous reports 1953-54 and 1954-55 for description of this experiment in which four grasses (*Cenchrus ciliaris*, *Chloris gayana*, *Pennisetum pedicellatum* and *Andropogon gayanus*, have been grown in spaced stands, rows, and continuous sward. Results are given for the complete experiment but residual root weights are not yet available. Tables 131, 132, 133 and 134 show respectively the yields of Dry Matter, Soluble Carbohydrate, Crude Protein and Phosphate for 1953, 1954, 1955 and the total for the three years.

TABLE 132.—EFFECTS OF SPACING ON FOUR GRASSES:
 DRY MATTER, 1953-1955

lb. per acre

<i>Species</i>	<i>Spaced</i>	<i>Rows</i>	<i>Sward</i>	<i>Species Means</i>
<i>1953 Yields</i>				
Cenchrus	2,170	3,237	1,837	2,415
Chloris	4,122	4,297	3,925	4,115
Pennisetum	3,025	3,918	2,147	3,030
Andropogon	3,490	4,632	3,268	3,797
Spacing Means	3,202	4,021	2,794	3,339
<i>1954 Yields</i>				
Cenchrus	2,409	2,174	1,607	2,063
Chloris	3,052	3,487	3,896	3,478
Pennisetum	5,160	3,289	1,706	3,385
Andropogon	5,422	5,217	4,464	5,034
Spacing Means	4,011	3,542	2,918	3,490
<i>1955 Yields:</i>				
Cenchrus	1,991	1,842	1,278	1,704
Chloris	2,602	2,781	2,326	2,570
Pennisetum	3,292	4,248	3,586	3,709
Andropogon	4,874	4,587	4,986	4,616
Spacing Means	3,190	3,365	3,044	3,150
<i>Total 1953-55</i>				
Cenchrus	6,570	7,275	4,722	6,183
Chloris	9,775	10,565	10,179	10,179
Pennisetum	11,477	11,455	7,439	10,124
Andropogon	13,782	14,436	12,197	13,646
Spacing Means	10,401	10,928	8,769	10,033
<i>Standard Errors</i>				
	1953	1954	1955	1953-55
Species Means	±324	±562	±357	±1,048
Spacing Means	±209	±366	±159	±603
Species x Spacing	±418	±732	±318	±1,206

TABLE 133.—EFFECT OF SPACING ON FOUR GRASSES:
SOLUBLE CARBOHYDRATE, 1953-55
lb. per acre nitrogen free extract

<i>Species</i>	<i>Spaced</i>	<i>Rows</i>	<i>Swartd</i>	<i>Species Means</i>
<i>1953 Yields:</i>				
Cenchrus	891	1,258	762	970
Chloris	1,766	1,929	1,782	1,826
Pennisetum	1,189	1,620	991	1,267
Andropogon	1,538	1,969	1,512	1,673
Spacing Means	1,346	1,694	1,262	1,434
<i>1954 Yields:</i>				
Cenchrus	1,021	894	540	818
Chloris	1,358	1,618	1,812	1,596
Pennisetum	1,315	1,380	729	1,141
Andropogon	2,624	2,489	2,019	2,377
Spacing Means	1,580	1,595	1,275	1,483
<i>1955 Yields:</i>				
Cenchrus	729	672	490	630
Chloris	1,223	1,357	1,170	1,232
Pennisetum	1,436	1,735	1,466	1,546
Andropogon	2,144	2,102	2,110	2,119
Spacing Means	1,383	1,466	1,296	1,382
<i>Total 1953-55:</i>				
Cenchrus	2,641	2,825	1,791	2,419
Chloris	4,347	4,903	4,711	4,654
Pennisetum	3,939	4,736	3,161	3,945
Andropogon	6,307	6,560	5,642	6,170
Spacing Means	4,309	4,756	3,826	4,297
<i>Standard Errors</i> ...	1953	1954	1955	1953-55
Species Means	±138	±210	±152	±444
Spacing Means	±93	±67.3	±60.7	±182
Species x Spacing ...	±186	±134.6	±121.7	±364

TABLE 134.—EFFECT OF SPACING ON FOUR GRASSES:
CRUDE PROTEIN—1953-55

lb. per acre and (percentage of Dry Matter)

<i>Species</i>	<i>Spaced</i>	<i>Rows</i>	<i>Sward</i>	<i>Species Means</i>
<i>1953 Yields:</i>				
Cenchrus	113.1 (5.2)	199.2 (6.1)	105.6 (5.7)	139.3 (5.8)
Chloris	206.3 (5.0)	193.1 (4.5)	147.8 (3.8)	182.4 (4.4)
Pennisetum	168.4 (5.6)	159.4 (4.1)	86.9 (4.1)	138.2 (4.6)
Andropogon	209.2 (6.0)	238.8 (5.2)	178.1 (5.4)	208.7 (5.5)
Spacing Means	174.3 (5.4)	197.6 (4.9)	129.6 (4.6)	167.2 (5.0)
<i>1954 Yields:</i>				
Cenchrus	112.4 (4.7)	117.9 (5.4)	74.2 (4.6)	101.5 (4.9)
Chloris	100.2 (3.3)	166.2 (4.7)	120.4 (3.1)	128.9 (3.7)
Pennisetum	11.54 (2.2)	151.0 (4.6)	71.9 (4.2)	112.8 (3.3)
Andropogon	200.2 (3.7)	165.5 (3.5)	158.2 (3.5)	174.6 (3.5)
Spacing Means	132.0 (3.3)	150.1 (4.2)	106.2 (3.6)	129.4 (3.7)
<i>1955 Yields:</i>				
Cenchrus	99.1 (5.0)	101.4 (5.5)	74.5 (5.8)	91.7 (5.4)
Chloris	96.5 (3.7)	80.6 (2.9)	89.4 (3.8)	88.9 (3.5)
Pennisetum	137.2 (4.2)	203.9 (4.8)	155.1 (4.3)	165.4 (4.5)
Andropogon	178.1 (3.7)	198.9 (4.3)	203.4 (4.1)	193.5 (4.2)
Spacing Means	127.7 (4.0)	146.2 (4.3)	130.6 (4.3)	134.9 (4.3)
<i>Total 1953-55:</i>				
Cenchrus	324.6 (4.9)	418.4 (5.8)	254.3 (5.4)	332.4 (5.4)
Chloris	402.9 (4.1)	439.9 (4.2)	357.4 (3.5)	400.1 (3.9)
Pennisetum	421.0 (3.7)	514.3 (4.5)	313.9 (4.2)	416.4 (4.1)
Andropogon	587.5 (4.3)	603.3 (4.2)	539.8 (4.2)	576.9 (4.2)
Spacing Means	434.0 (4.2)	493.9 (4.5)	366.4 (4.2)	431.4 (4.3)
<i>Standard Errors:</i>				
	1953	1954	1955	1953-55
Species Means	±14.6	±16.6	±15.6	±38
Spacing Means	±10.7	± 6.5	± 7.1	±18.9
Species x Spacing	±21.4	±13.0	±14.2	±37.9

TABLE 135.—EFFECT OF SPACING ON FOUR GRASSES:
PHOSPHATE CONTENT—1953-55

lb. P² O⁵ per acre and (percentage of Dry Matter)

<i>Species</i>	<i>Spaced</i>	<i>Rows</i>	<i>Sward</i>	<i>Species Means</i>
<i>1953 Yields:</i>				
Cenchrus	6.03 (0.28)	10.57 (0.33)	6.29 (0.34)	7.63 (0.32)
Chloris	11.31 (0.27)	11.46 (0.27)	14.27 (0.34)	12.35 (0.30)
Pennisetum	8.05 (0.27)	9.84 (0.25)	6.34 (0.30)	8.08 (0.27)
Andropogon	9.11 (0.26)	10.72 (0.23)	8.69 (0.26)	9.51 (0.25)
Spacing Means	8.60 (0.27)	10.65 (0.27)	8.90 (0.32)	9.39 (0.28)
<i>1954 Yields:</i>				
Cenchrus	10.72 (0.45)	6.42 (0.30)	5.66 (0.35)	7.60 (0.37)
Chloris	6.65 (0.22)	6.11 (0.18)	8.43 (0.22)	7.06 (0.20)
Pennisetum	8.04 (0.16)	7.54 (0.23)	5.31 (0.31)	6.96 (0.21)
Andropogon	11.89 (0.22)	9.70 (0.19)	11.12 (0.25)	10.90 (0.22)
Spacing Means	9.33 (0.23)	7.44 (0.21)	7.63 (0.26)	8.13 (0.23)
<i>1955 Yields:</i>				
Cenchrus	6.22 (0.32)	5.89 (0.32)	4.64 (0.38)	5.58 (0.33)
Chloris	5.67 (0.22)	6.34 (0.23)	7.65 (0.33)	6.55 (0.26)
Pennisetum	10.13 (0.31)	13.47 (0.32)	10.60 (0.30)	11.30 (0.31)
Andropogon	8.46 (0.17)	11.52 (0.25)	13.14 (0.25)	11.04 (0.24)
Spacing Means	7.62 (0.24)	9.31 (0.28)	9.01 (0.30)	8.64 (0.27)
<i>Total 1953-55:</i>				
Cenchrus	22.98 (0.35)	22.88 (0.31)	16.59 (0.35)	20.82 (0.32)
Chloris	23.63 (0.24)	23.91 (0.23)	30.34 (0.29)	25.96 (0.26)
Pennisetum	26.21 (0.23)	40.86 (0.36)	22.25 (0.30)	29.77 (0.29)
Andropogon	29.48 (0.21)	31.94 (0.22)	32.95 (0.26)	31.46 (0.23)
Spacing Means	25.58 (0.25)	29.90 (0.27)	25.53 (0.29)	27.00 (0.28)
<i>Standard Errors:</i>				
Species Means	1953 ±1.06	1954 ±0.85	1955 ±0.78	1953-55 ±2.39
Spacing Means	±0.65	±0.41	±0.32	±1.14
Species x Spacing	±1.30	±0.82	±0.64	±2.28

After two years the sward showed much bare ground and the plant populations were smaller. A fairly low population would appear most favourable for maximum production. The performance of the species is markedly different, note the falling off in productivity of the Chloris and Cenchrus over the three years.

SEED MULTIPLICATION EXPERIMENT (W.H.F.)

An experiment was laid down in June, 1955, to investigate the effect of certain factors upon the seed production of *Chloris gayana*, and to measure its vegetative production when grown for seed under the influence of these factors. A seed harvest was taken in the first, and will be taken in subsequent years. Measurements have been made of seed yield, dry matter (D.M.) yield of the herbage, crude protein percentage (C.P. per cent) and phosphate percentage (P_2O_5 per cent) of the herbage.

Seed was sown in rows spaced 2' (W1) or 1' (W0) apart. With treatment W1 seed was sown at the rate of 2 lb. per acre; with W0 at 4 lb. per acre. Four fertiliser treatments were applied; all combinations of sulphate of ammonia at 0 (N0) or 100 (N1) lb. per acre and superphosphate at 0 (P0) or 100 (P1) lb. per acre. Fertiliser was surface-sown on 26-7-56. There were three cutting treatments (C1, C2 and C3). Under treatments C1 an early pre-harvest cut (5-8-55) was followed by a seed cut (11-10-55). Treatment C2 had a later pre-harvest cut (2-9-55) followed by a seed cut (5-11-55). Treatment C3 had no pre-harvest cut but a seed cut (23-9-55) followed by a post-harvest cut (23-11-55).

The yield of green material from the first cut with cutting treatment C1 was so small that it was not recorded. The three cutting treatments can thus be described as follows:—

- C1 Light cutting treatment, overwintering with fair growth.
- C2 Early and heavy cutting, overwintering in short condition.
- C3 Late and heavy cutting, overwintering in short condition.

Seed production was increased significantly * by the dressing of sulphate of ammonia, but superphosphate had no effect:

							lb.	
N1	...	...	...	...	...	...	306	} per acre
N0	...	...	...	...	...	...	244	
P1	...	...	...	...	...	...	273	
P0	...	...	...	...	...	...	277	

The wider spacing treatment, although the plots had been sown with only half the seed compared to the W0 plots, yielded a non significantly greater quantity of seed.

							lb.	
W1	...	...	...	...	...	...	289	} per acre
W0	...	...	...	...	...	...	261	

This fact is of obvious importance in the faster multiplication of basic seed stocks.

The cutting treatments caused differences, all highly significant *** in seed production,

C1	...	...	...	...	...	318 lb. per acre
C2	...	...	...	...	...	128 lb. per acre
C3	...	...	...	...	...	378 lb. per acre

The effect of taking a cut before seed harvest is to lower the resulting yield of seed most markedly (C2). Although the first cut with treatment C1 was considered negligible in quantity, it must have had considerably physiological effects in depressing seed yield and retarding its date of maturity. Although cutting treatment C3 gave the largest seed yield, the lushness of the vegetation caused the crop to become laid. Also the seed crop was ready for cutting before the end of the rains, an undesirable feature as it was difficult to dry the seed without moulds forming.

The interaction of cutting date and application of sulphate of ammonial approaches significance.

					C1	C2	C3
N1	...	...	...	...	368	136	414
N0	...	...	...	...	268	119	343

This is presumably an example of the different effects of Nitrogenous fertilisers applied at different intervals before cutting date; in one case increasing vegetative production, in another seed production. The equivalent table for dry matter production in lb. per acre is:—

					C1	C2	C3
N1	...	...	...	...	6,280	7,730	7,910
N0	...	...	...	...	5,280	5,750	7,180

A negative correlation between the two tables is apparent, nitrogen in the case of treatment C2 being utilised in vegetative production.

Dry matter figures show the increase in yield by withholding the first cut until 23rd September compared to 2nd September. (Table 136).

TABLE 136.—EFFECT OF DATE OF FIRST CUT ON YIELD
lb. Dry Matter per acre

Cutting Treatment				C2		C3	
Date of Cut	...	...		2/9	5/11	23/9	23/11
Yield of D.M.	...	...		4,830	1,910	5,830	1,720

Protein percentages follow a reverse trend. (Table 138). Regrowths¹ are approximately equal in D.M. production with either cutting treatment.

Although the wide drills gave less D.M. production—

W1	...	...	...	...	6,260 lb. per acre
W0	...	...	...	...	7,130 lb. per acre,

there are indications that have a use in late season production. (Table 137).

TABLE 137.—EFFECT OF ROW WIDTH AND CUTTING DATE ON YIELD
lb. Dry Matter per acre

Cutting	C 1		C 2				C 3			
Date of Cut	11 Nov.		2 Sept.		5 Nov.		23 Sept.		23 Nov.	
Width of Row	Wide	Narrow	Wide	Narrow	Wide	Narrow	Wide	Narrow	Wide	Narrow
Yield of D.M.	5,380	6,190	4,170	5,500	1,870	1,950	5,530	6,140	1,840	1,610
Percentage of Cut ...	46	54	43	57	49	51	47	53	53	47

Sulphate of ammonia caused a greater improvement in D.M. production than superphosphate.

N1 ...	...	7,300 lb. per acre	P1 ...	6,860 lb. per acre
N2 ...	...	6,070 lb. per acre	P0 ...	6,520 lb. per acre

TABLE 138.—CRUDE PROTEIN PERCENTAGE IN YIELD
Percentage Crude Protein

Cutting Treatment	C1		C2				C3			
Row Spacing	Wide	Narrow	Wide		Narrow		Wide		Narrow	
Date of Cut	11/10	11/10	2/9	5/11	2/9	5/11	23/9	23/11	23/9	23/11
Fertiliser										
N1P0 ...	4.3	4.7	6.1	4.9	7.4	4.5	5.3	4.1	4.7	4.3
N1P1 ...	4.8	4.6	6.6	4.2	6.7	4.4	4.8	4.5	5.1	4.5
N0P1 ...	4.3	4.2	6.7	4.4	5.7	4.1	4.7	4.4	4.3	4.4
N0P0 ...	4.6	5.5	7.2	4.4	5.6	4.3	4.6	4.8	4.3	4.1

The difference in Crude Protein percentage (Table 138) with different dates of first cut (i.e., C2 and C3) has been remarked upon already, and also that these differences are inversely correlated to D.M. Production (Table 136). It is noticeable that there is no discernable increase in Crude Protein percentage due to wider spacing, or to applications of nitrogenous fertiliser.

Phosphate percentages of the dry matter were not increased as might be expected, by applying superphosphate fertiliser, or by the wider spacing treatment.

Next year it is intended to measure the residual effects of the application of superphosphate, and also the effect of the three, contrasting first year cutting treatments. As the crop is now established, the seed harvest is expected to be earlier. All plots will therefore received a common cutting of grazing at approximately mid July. Four different manurial treatments will be used; sulphate of ammonia at 1 or 3 cwt. per acre, applied either in one or split dressings.

Results from this experiment to date will be applied to seed multiplication undertaken this year.

Trial of Annual Grasses:—This experiment was designed to compare the yield of three annual grasses, *Rottboellia exaltata*, *Pennisetum pedicellatum* at 21 and a Sorghum variety. In addition for purposes of comparison a perennial *Chloris gayana* interplanted with *Phaseolus lathyroides* was introduced.

Half the plots received 3 tons per acre F.Y.M. before planting and the plots were split for cutting—sub-plots were cut once (at sixteen weeks after planting) and twice (at twelve weeks and twenty weeks after planting). Yields are shown in Table 139.

TABLE 139.—YIELDS OF ANNUAL GRASSES
lb. dry matter per acre

<i>Species:</i>							***	S.E.
Chloris and Phaseolus	...	...	...	...	...	...	3173	±274
Rottboellia	...	...	...	...	...	...	3551	
Sorghum	...	...	...	...	...	...	4038	
Pennisetum	...	...	...	...	...	...	6644	
<i>Cutting:</i>							N.S.	±224
Once cut	...	...	...	...	...	...	4090	
Twice cut	...	...	...	...	...	...	4610	
<i>Manure:</i>							*	±388
3 ton per acre	...	...	...	...	...	...	4970	
Nil	...	...	...	...	...	...	3740	
<i>Interaction***</i>								±447
					<i>Once</i>	<i>Twice</i>		
Chloris and Phaseolus	...	...	...	...	3047	3300		
Rottboellia	...	...	...	...	4300	2802		
Sorghum	...	...	...	...	2485	5590		
Pennisetum	...	...	...	...	6532	6755		

Trial on Utilisation of Natural Savannah Grassland for Livestock Production.—In this trial twelve paddocks of 4½ acres were fenced, of the twelve, nine were cleared of scrub by stumping. Three paddocks comprise a unit, which is managed independently of other paddocks. It is intended that three paddocks (13½ acres) shall maintain and provide for growth of three to four-year old steers.

- Managements—Grazing and Burning on uncleared land.
Grazing and burning on cleared land.
Grazing and conserving Hay and Silage on cleared land.
Grazing and conserving Hay and Silage and burning on cleared land.

In addition three steers of the same age run with farm stock which are penned nightly and taken out each day for grazing.

The trial was started on 1st June, 1955 and up to time of writing (1st April, 1956) all the animals have remained healthy. They have received Antrycide prosalt every two months.

Between 1st June and 1st December, the animals in the uncleared paddocks gained only 34 lb. per animal although there always appeared sufficient grass. Since 1st December they have received 2 lb. concentrate ration (ground guineacorn, cotton-seed, groundnut cake) per day in addition to the grazing and have gained a further 15 lb.

The animals in the other systems of management made a rapid increase during June and July when they gained 50 lb. Between 1st August and 1st December the gain was slower being 60 lb. During the four months from the 1st December, these animals have lost 50 lb. in spite of feeding back hay and silage to two groups of animals.

The animals running with the farm stock gained 110 lb. during the period from 1st June to 1st December. Since 22nd November they have received 2 lb. concentrate daily and in the four months to the end of March have gained a further 25 lb.

The experiment has not run a full year so discussion must be limited. The value of hay or silage must be considered, not only in terms of its feeding value but also in terms of reduced productivity of a pasture which results from mowing. However the value of mowing in keeping down scrub regrowth is considerable. It is hoped that benefit from the dung combined with the reduction in scrub growth will increase the carrying capacity of the mown paddocks.

Natural Grass Management Studies—See 1954-55 Report for earlier observations. This trial has been used as the basis for a further series of observation plots, on which the bush has not been cleared, and treatments consist of grazing and burning: the burning is carried out just prior to and just after the arrival of the rains, annually, every second year and every third year. The use of fire at the end of the dry season appears a promising means of controlling scrub.

Trial on Grazing and Cutting Sward.—In this experiment it is intended to investigate the behaviour and productivity of a sown sward.

The seed mixture consisted of:—

Chloris gayana	...	...	...	3 lb. per acre
Alysicarpus vaginalis	...	...	...	1 lb.
Stylosanthes gracilis	...	...	...	1 lb.

and was sown in June, 1955. The low rates were due to shortage of seed.

Treatments are:—

Early Grazing	{ Late Grazing
	{ Late Mowing
Early Mowing	{ Late Grazing
	{ Late Mowing.

By "Early" is meant the first four months of the rains.

A further treatment is the application of superphosphate. Rates are nil: 1 cwt. annually.

There have been late grazings and late mowings in September and November. In September the average yield was 3,000 lb. D.M. per acre and in November 1,500 lb. D.M. per acre. No differences appeared in the composition of the plots in November as a result of grazing or mowing in September.

A.D.N.P. (each factor at 3 levels) experiment on a sown pasture and an experiment on silage production using *Panicum maximum* sown in alternate wide rows with each of four legumes, *Pueraria phaseoloides*, *Phaseolus lathyroides*, *Stylosanthes gracilis* and *Cajanus cajan*, have been started.

Methods of establishing a *Chloris gayana* pasture using different cover crops and different seed rates are being investigated.

VIII.—ANIMAL BREEDING

(By D. R. Williams)

Cattle Multiplication Centres.—This year for the first time, enough records have accumulated at the Cattle Multiplication Centres mentioned to estimate the usefulness of the methods of milk recording adopted.

At the Cattle Multiplication Centres at Talata Mafara and Kwartarkwashi, the lactating Cows and Heifers are milked on two days each week and the calf allowed to suckle on the remaining days. Total yield is estimated from the two days per week yield.

Estimated yields at these two Cattle Multiplication Centres are:

C.M.C.			No. of Lactations	Average Yield	Average Length
Talata Mafara	...	...	17	1,129 lb	247 days
Kwartarkwashi	...	...	20	729 lb	170 days

At Talata Mafara only three lactations of nineteen, twenty-eight and 147 days were shorter than 200 days and the remainder ranged from 217 to 350 days.

At Kwartarkwashi, there were four lactations below 100 days and ten between 100 and 200 days.

At Kabomo Cattle Multiplication Centre, milking is one day per week only and total yield is estimated from this.

The estimated yields on this system are:—

						<i>Cow or Heifer No.</i>	<i>Days in milk</i>	<i>Estimated yield lb.</i>
1	...	...	...	...	...	K12	370	1,810
2	...	...	...	...	...	160	258	1,050
3	...	...	...	...	...	133	232	760
4	...	...	...	...	...	169	210	710
5	...	...	...	...	...	88	211	600

The calves of K12 and 88 gained in weight at the rate of 14.7 and 13.5 lb. per week over the first eighteen weeks and only differed by about 10 lb. in weight at the 10th week.

At all the Cattle Multiplication Centres, there are even fewer records than at those noted, but the existing records show that the one or two milking methods do not give any real measure of the cow's or heifer's producing ability and it has been decided to stop such recording at C.M.C.s.

Instead, because of the very high correlation (0.9) found between length and yield with the White Fulani at Shika and also with the Adamawa Gudale at Bambiri (*see later*) reliance will be placed on length of lactation and growth rate of the calf for detecting any outstanding animals in the first place.

Records.—To date, emphasis has been placed mostly upon milk production and records have been sent in to Samaru from the following centres:—

<i>Centre</i>	<i>Department</i>	<i>Breed</i>
1. Bambiri	Agriculture (S. Cameroons)	Adamawa Gudale type (Banjo and Ngawadere)
2. Jakiri (Bamenda)	Veterinary (S. Cameroons)	Mentbelliard, Adamawa Gudale and crosses
3. Maiduguri	Agriculture	Shuwa
4. Vom	Veterinary	White Fulani and Friesian crosses
5. Yandev and Raav ...	Agriculture	N'dama and Muturu
6. Yola	Agriculture	Adamawa Gudale
7. Shika	Agriculture	White Fulani and Sokoto

Considerable progress has been made in compiling record books from the information sent from each centre for easy reference to any data required. This is still not completed, but will be put in hand again when a reliable assistant is appointed.

1. *Bambiri*.—At Bambiri in the Southern Cameroons a herd of Adamawa Gudale cattle have been kept since 1944. These cattle are similar to the medium-sized Zebu common to Adamawa Province and the Cameroons, and some characteristics of their milking performance have been examined.

The average length of 317 lactations recorded was 211 ± 5.1 days and the average yield was 1347 ± 30.3 lb. with a correlation coefficient of 0.9 between length of lactation and yield. The coefficients of variation of the above averages were 42.8 per cent and 39.8 per cent respectively. Data from these 317 lactations are presented in Table 140.

TABLE 140.—DATA ON LACTATIONS, BAMBIRI

<i>Period in Days</i>		<i>No. of Lactations</i>	<i>Mean Days</i>	<i>Mean yield-lb</i>	<i>lb per day in milk</i>
0-50	...	5	42.2	392.60	9.30
51-100	...	25	73.2	490.76	6.70
101-150	...	38	127.0	817.92	6.44
151-200	...	76	162.7	1102.30	6.71
201-250	...	85	224.0	1389.53	6.20
251-300	...	41	271.4	1722.02	6.34
301-350	...	23	323.9	2103.17	6.49
350+	...	24	417.1	2536.75	6.08

Heritabilities have not been calculated, but with such low yields it is unlikely that a good dairy breed could be developed rapidly from such basic stock without crossing with one of the larger and more productive breeds such as White Fulani. An alternative policy would be to attempt to develop a beef type, using the length of lactation as a guide to ensure that an adequate level of milk production is maintained for suckling calves.

2. *Jakiri*.—The Adamawa Gudale type of cattle kept here are similar to those at Bambiri and both stations are situated in similar environments. Pedigree records were prepared from the information sent to Samaru, preparatory to examining the milking potentialities of the breed, but it was later found that owing to a confused system of recording it was not possible to relate the milk records to animals of known ancestry. An explanation of the numbering systems is being sent from Jakiri, so that the examination can continue.

However, as the level of milk performance is somewhat similar to that at Bambiri, the introduction of "blood" from other breeds would seem to be necessary to create a dairy breed. This is in fact being done by crossing with Montbelliard.

As at Bambiri, an alternative policy would be to attempt to develop on beef lines, and a start has been made to estimate the heritability of those characters important for beef production (birth weights, weaning weights, rates of gain, natural weights, etc.) in order to judge the potentiality of the breed for beef.

The heritability of birth weight is estimated from the correlations between full sibs and half sibs and their unrelated contemporaries. Only paternal half-sisters, maternal half-sisters and full sisters have so far been examined and this gives an estimate of 0.44 to 0.48 for the heritability of birth weight. This cannot be accepted as reliable until the whole series of correlations have been calculated.

3. *Shika: A. White Fulani*.—The following characteristics of lactation performance in the higher herd of White Fulani have been estimated (2,037 lactations).

<i>Items</i>				<i>Length days</i>	<i>Yield in lb.</i>
Average	...	...	...	215.4	1,918.2
Coeff. of Variation	...	...	...	34.8%	47%

Correlation between length and yield = 0.89

Using the calculated heritability figures ($h^2 = 0.32$ for 1 record and 0.47 for 2 records) the Relative Breeding Values of the female stock at Shika have been estimated and it was found that thirty White Fulani cows (based on two lactations) have Relative Breeding Values of over 110 per cent, with two cows over 160 per cent.

These cows are being used to breed bulls and the rest of the herd is being used to progeny test young bulls.

Bull calves born to any of these cows may be suckled either on their dams or upon nurse cows in order to reduce the age at which bulls can first be used for service, as a calf suckling trial at Shika has shown conclusively that this reduces the age at which they can be used by five to seven months as compared with their bucket-fed contemporaries.

The results of the trial are summarised in Tables 141 and 142.

TABLE 141.—CALF SUCKLING TRIAL, WHITE FULANI HERD, SHIKA

<i>No. of Bull Calf</i>	<i>Pair 1</i>		<i>Pair 2</i>		<i>Pair 3</i>	
	151	153	162	164	203	196
Date of Birth	19-6-54	24-6-54	10-8-54	17-8-54	12-1-55	24-12-54
Birth weight	51 lb	51	54	54	45	42
Weaning weight	461 lb	221	439	172	415	188
Weight at one year	462 lb	348	460	260	460	250
Weight at end March, 1956	614 lb	442	610	378	546	328
Days on milk	308	186	308	245	308	213

(Calves 151, 162 and 203 were the suckled members of the pairs).

TABLE 142.—CALF SUCKLING TRIAL, SOKOTO BREED, SHIKA

No. of Bull Calf	Pair 1		Pair 2	
	253	255	257	260
Date of Birth	13-8-54	18-8-54	22-8-54	26-8-54
Birth Weight	52	60	49	67
Weaning weight	422	193	526	200
Weight at one year	476	346	542	294
Weight at end March, 1956	646	473	753	330
Days on milk	275	181	308	186

(Calves 253 and 257 were suckled).

The Mating System adopted is designed to limit interbreeding as far as possible, as it has been found that inbreeding was leading to a decline in birth weight and to an increased calf mortality.

Sokoto Gudale.—The mean yield for 816 lactations was 2084.2 lb. and the length was 221.2 days. Variability is smaller than in the White Fulani herd, but accurate estimates have not yet been made. Preliminary estimates of heritability for yield, based on daughter dam comparisons give a value for h^2 of between 0.19 to 0.24 for one lactation. The true value is yet to be checked but it is evident that heritability is lower in the Gudale herd than in the Fulani herd, 0.2 is being used for the time being in the calculation of Relative Breeding Values to be used in arranging the breeding schedules for the year.

Goats and Sheep: At Bulasa.—(Birnin Kebbi) about 365 Red Sokoto Goats have been brought in or reared since 1950. A breeding programme has been planned, which is designed to improve the average quality in the herd of the hides from which Morocco leather is made.

The goats comprise colour types from dark red with a well defined ridge of black hairs along back on head, etc., to the lightest fawn and there are important differences in the quality of the dried skins of dark and light coloured goats, showing up particularly well in skins which are dark, but have large fawn patches, etc.

Breeding has been planned to clarify the mechanism of colour inheritance, while at the same time systematic examination and recording is to be made of colour marking and hide quality of the skins of all goats which die or are slaughtered.

At first, all the goats were run together in one large herd and under this method, systematic breeding was difficult. It has now been found that a number of smaller herds can be kept housed together in adjacent pens,

but grazing separately. One Billy and ten to twelve Nannies which have not previously been brought together can be trained to run together by keeping them in one pen for four or more days. Thereafter, the group forms an independent herd, grazing together and each goat returning to the herd pen when brought in from grazing, with only occasional direction by the herdsman. In this way eight small herds, which do not intermix have been built up over the past eighteen months. This makes systematic breeding simple to organise.

The billies and nannies of each herd have been chosen to give a selection of crosses between various colour types, from the progeny of which it will be possible to work out the mechanism of colour inheritance.

At present four of the billies which have left progeny in the herd were still at Bulassa in February, 1956, but this only allowed progeny parent comparisons to be made with five full sib triplets, three full sib pairs and twenty-two single kids.

Indications are that goat colour is inherited in a fairly simple Mendelian manner, but it is impossible at this stage to be sure of this, or to identify the genotypes which correspond to particular phenotypes. It is hoped to have the answer in about one year from now.

IX—SOIL SURVEY SECTION

By G. M. Higgins

Since the formation of the Department of Agriculture in Nigeria, the need for a soil survey of the country has been fully recognised but it is only during the present year that the formation of a separate soil survey section has been possible in the Northern Region Department.

As far back as 1930 soils from various areas were being collected and examined, chiefly by the Agricultural Chemists, the main emphasis being placed on subsequent physical and chemical analyses. Surveys of special projects were also carried out, but it was not until the last decade that field examination of the soils assumed its most important role in the investigations. During the last few years, surveys carried out by the Agricultural Chemists had emphasised the very great need for a soil survey of the whole country, and to advise on the best method to form a team to carry out this work, a visit was paid to the Region by Dr A. Muir, Head of Soil Survey of England and Wales; the new soil survey section was formed as a result of this visit.

Present proposals are for the team to consist of one senior specialist, three soil scientists and three specialist assistants, together with the requisite number of junior staff. In the present account the work was carried out by one member of the team during the second half of the year, three other members of the team being expected in 1956.

As expected, at the commencement of the survey the prime need was for small scale surveys of areas such as experimental farms, extensions to experimental stations and proposed sites for special projects. Three such

sites occurred within an area of 400 square miles in Kano Province, including the experimental stations of Kano and Danbatta, in addition to the reclamation area at Badume. Detailed soil surveys were required at all three sites and in order to demarcate the areas of which they could be considered typical a start was also made on a reconnaissance survey of the connecting areas, making full use of aerial photographs which were available. The area as a whole is an extremely important one, primarily producing food crops for the large population of Kano city. During the last thirty years, however, considerable areas have been invaded by the shrub known locally as sabara (*Guiera senegalensis*), which is being continually cut by the local population for firewood and grazed by their livestock. Any attempt at cultivation by the local farmers inevitably results in a crop failure, with the result that these communal grazing areas are liable to severe erosion. The secondary aim of the survey was, therefore, to ascertain if any correlation existed between the soils and the occurrence of these infertile areas.

The geology of the area has been classified as pre-Cambrian undifferentiated basement complex, consisting mainly of granitic gneisses, over which a drift, probably loess type, has been super-imposed. Average rainfall for the area, as recorded at Kano experimental farm, is 32 inches, occurring mainly in the months of July and August, with a very marked dry season from October until March. The topography of the area so far surveyed consists of long gentle slopes up to one mile in length, rising to the uncultivated, treeless, infertile sabara infested areas, and sloping down to the cultivated areas of village sites, which in every case contain large numbers of 'Dorowa' (*Parkia Clapitonia*) trees.

At the present time, an area of approximately 80 square miles has been surveyed and the soils provisionally classified into two main divisions (a) predominantly reddish friable loamy sands to sandy clays overlying some form of ironpan and (b) predominantly greyish, yellow-grey, water deposited, coarse sands to clay usually heavily mottled and associated with the lower lying areas. The detailed Badume survey has shown all soils occurring within the reclamation area to be those of division (a). The origin of these 'drift' soils is obscure and until such time as knowledge on their mode of formation is available all classifications at present adopted divides these soils into two major groups, depending upon the type of ironpan present, whether of the solid sheet type or whether of the more recent crumbly, rotting rock type. Further subdivision into series is based upon depth and type of material above the ironpan. This association of soils covers the majority of the reconnaissance area so far surveyed with, in general, no correlation between the soils and the infertile sabara area. Remnants of the old solid sheet ironpan occur on the crests of all the slopes and the soils containing crumbly ironpan near the surface occupy most of the sabara infested areas. Large areas of the latter soils however also occur in the cultivated areas with Dorowa trees. There is little doubt that ironpan effectively prevents roots of the majority of plants and shrubs penetrating to the nutrient-rich underlying

layer; investigations carried out showed that even the strong tap root of the sabara shrub turns at right angles and runs along the top of the ironpan layer. At present it would appear that the reason for crop failures and sabara invasion of these soils is exhaustion of fertility, cultivation in the village areas on the same soils being maintained by (a) the use of compost and (b) the occurrence of large numbers of ironpan-penetrating trees which act as nutrient pumps, bringing nutrients to the surface *via* their leaf-fall.

This theory is supported, to some extent, by the examination of the infertile sabara invaded soils of Danbatta. Although the detailed soil survey of this station has not yet been carried out, preliminary soil investigations have revealed a major soil change to large depths, (up to 15 feet), of undifferentiated red acid friable sandy loam (PH=5.0) overlying an ironpan layer. It is considered that at this depth the ironpan layer cannot materially affect the plants' root growth and that lack of fertility, therefore, is the main cause of these poor areas.

A major soil change also occurs between the two areas mentioned and Kano experimental farm itself. The detailed survey of this station, together with that of the proposed groundnut extension having been carried out in December and January. The soils proved to be exceedingly complex, the original grid of 100 yards having to be reduced finally to 40 yards in an attempt to make sense of the soil pattern. At the present time, it would appear that the soils of the station fall into two main divisions (a) 'sedentary' soils formed on basement complex, (b) transported soils, varying from heavy clays to coarse sands. The problem of the loess type of drift mentioned above also enters into the classification of the soils, making it at present purely provisional. Subdivision of (b) soils into series was carried out, but the so-called sedentary soils proved more difficult to classify. Final classification is awaiting the completion of the laboratory analyses.

The manner in which these analyses will be used is illustrated by reference to the profile of one of the middle slope members of the division. The profile consists of eight inches of light brown sand gradually merging into forty-two inches of reddish yellow sandy loam which, in turn, grades into twenty inches of brownish yellow light sandy clay down to seventy inches. Distributed fairly evenly throughout the profile occur small pieces (1-2mm. diameter) of angular quartz grains. This type of profile could have been developed *in situ* from the coarse grained granitic gneiss which occurs as outcrops in the area, but at seventy inches there occurs a sixteen inch deep horizon of very pale brown coarse sand which, from the field examination, could only have been derived from an entirely different source of material than the overlying horizons. If laboratory examination proves this to be correct, it must be assumed that all the seventy inches of material above it must be transported and not sedentary. Further examination will then be required to ascertain if it has been derived from the upper slope sedentary soils (if, indeed, they themselves are truly sedentary) or whether it is part of a more general drift over the whole area.

If these soils do prove to have been derived from drift sources, the large depth of material and textural development of the profile indicate their great age.

At the end of the year a further soil survey was carried out also in Kano Province, of a flood plain area approximately 100 miles to the north east of the city, near the ancient town of Hadeija. No previous information had been obtained by the Department in this area, the object of the survey being to obtain information on both the vegetation and soils, and also on any correlation which may exist between the two. Information was also required on any relationship between vegetation and depth of flood water with particular reference to rice growing possibilities. The vegetation and geomorphology of the area were fully described by the Federal Ecologist, Ibadan (Mr Clayton) during an ecological survey of the area which was carried out three months prior to the soil survey. His findings indicate a present day flood plain comprised of a maze of swamps, levees, lakes and meanders, the soils being predominantly greyish, sandy silts and supporting mainly tussocky *Vetiveria nigritana*. An older alluvial terrace is separated from this meander belt by a sharp incline, marking the main boundary between the seasonally flooded and non-seasonally flooded areas, the vegetation of the latter being comprised mainly of ziziphus scrub, Givera scrub and Acacia bushland. The most distinctive feature of the topography, however, is the occurrence of longitudinal dunes of desert sand aligned in the direction of the prevailing wind, in some cases nearly 100 feet high and, in the main, occupied by areas of village sites and highly concentrated cultivation.

The subsequent reconnaissance soil survey confirmed these findings over an area of approximately 100 square miles, 25 miles of footpath traces being covered and inspection borings down to 5 feet being examined at every 200 yards along their length. Samples at 6 inch depths were taken from the borings and described at the base camp. Profile pits down to 7 feet were inspected, sampled and described in the field, in areas representative of individual series.

The geology of the area consists of the metamorphic basement rocks which presumably floor the Chad basin and outcrop round its rim, covered by a great depth of the Chad sediments, which are presumably water deposited, and have been reported to be at least 300 feet deep. Superimposed on top of these sediments occurs a relatively shallow and more recent drift sand. The average annual rainfall for the area is 25 inches, occurring mainly in July and August, with a very marked dry season for six months in the year.

Three main soil associations were recognised during the survey in the main corresponding with Clayton's topographical units and differentiated on the basis of the age of the soils. The survey having only recently been completed, no analyses are yet available for the soils and no place names

have yet been used for either the associations or their series. The Dune Association, as its descriptive name implies, is always associated with the old longitudinal dunes of desert sand and consists simply of two series, the upper and the lower slope members differentiated solely on their drainage conditions as indicated by the colour of the sollum. Texturally, both are identical, consisting of loose, structureless, undifferentiated, almost pure sand, the colour of the upper member being reddish yellow and that of the lower member, pale brown. Cultivation in the area is confined mainly to these soils except for the intensively cultivated region surrounding Hadeija town.

The second association, described as the old flood plain association, consists of a wide variety of soils, ranging from light loamy sands derived from remnants of old dunes, to heavy cracking clays supporting an almost pure stand of *oryza* grassland. Surrounding the isolated patches of the latter occurs another clay series bearing *Acacia seyal* bushland, the clay being lighter, however, in both colour and texture. The main series occurring within the association, consists of six inches of pale brown loamy sand regularly grading into very compact, light clay at thirty inches, overlying the masses of calcium carbonate concretions which extend to depth. The PH of the lower horizons is 8.5 and the effects of dressings of this material on the leached, acid soils of the Dune association is to be investigated.

The final association, provisionally named the new flood plain association, consists of a great variety of soils which at present have only been classified into two main divisions:—

- (a) predominantly silty, bearing *Vetiveria* grassland
- (b) predominantly clayed, bearing *Oryza* grassland.

The seasonally flooded soils, of relatively recent deposition, show such wide variation, (varying amounts of silt and sand occurring in the profile at different depths), that it is considered necessary to map this association as a complex, despite the main vegetation and soil correlation.

In general, over the area surveyed, a very good correlation was found to exist between soils and vegetation, and the possibility of large scale rice cultivation on the soils of the new flood plain is worthy of consideration.

In addition to the surveying carried out during the year, a visit was made by the Soil Survey Officer to the Soil and Land Use Survey Department of the Gold Coast, to make contact with the experienced surveyors there and to study their methods of soil surveying and classification. The Northern Nigerian team is to operate using the same methods as those employed in the Gold Coast and it is hoped to start the systematic survey of the Region in 1956.

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